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HISTOPLASMOSIS AND ITS IMPORTANCE TO OTO-RHINOLARYNGOLOGISTS. A REVIEW WITH REPORT OF A NEW CASE.

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Histoplasmosis, Darling's disease, reticulo-endothelial cytomycosis or histiocytosis is a fungous infection caused by organisms of the genus Histoplasma (H. capsulatum, H. pyriforme). The disease is characterized usually by fever, loss of weight or emaciation, anemia, leukopenia and splenohepatomegaly with a marked invasion by reticulo-endothelial histiocytes containing organisms. It may be cutaneous or systemic, localized or generalized, involving the skin, spleen, liver, lungs, lymph nodes, adrenals, kidneys, pleura, prostate, heart, brain, larynx, ear, nose, eye, bone, bone marrow, periosteal tissue, gastro-intestinal tract and other accessory organs. The disease may be acute or chronic, lasting from a few weeks to many years, but is invariably fatal.

Histoplasmosis has rapidly come to the foreground within the past few years, after a lapse of many years from the time it was first

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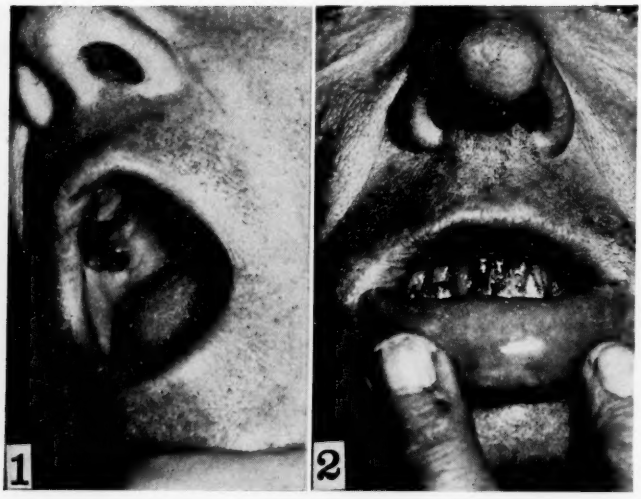

Fig. 1.—Ulcerous lesion on inner edge of upper right alveolar border.

Fig. 2.—Lower molars showing dirty, carious condition.

described. In order to bring this important fungous disease to the attention of those interested in lesions of the ear, nose and throat, the salient features of this mycosis will be emphasized. The bibliography on reticulo-endothelial cytomycosis, as it may be more properly designated, contains over 100 published papers dealing with either case reports or mycologic discussions. At least 70 cases, published, referred to or known, have come to the attention of those interested.

From the standpoint of otorhinolaryngologists, histoplasmosis should be an important clinical entity because of its various complications, its ability to simulate known diseases such as carcinoma, otitis media, rhinoscleroma, laryngeal tuberculosis, aleukemic leukemia, lymphoma, noma, leishmaniasis and others.

Accordingly, we are presenting a case of histoplasmosis with involvement of the buccal mucosa and hard palate which simulated carcinoma, with a review of the known cases of otorhinolaryngological interest. Lesions of the respiratory tract are characterized by cough, sore throat, hoarseness, dyspnea, rhinitis and rhinorrhagia. Involvement of the ear, nose and throat is either primary or secondary to a deep-seated infectious process. Such symptoms usually bring the patient to the attention of the otorhinolaryngologist.

REPORT OF A CASE

P. S., a white, 67-year-old man, who was married and had five children living and well, was first seen on Aug. 17, 1942, complaining of a "sore" in the roof of the mouth. This "sore" had begun two months previously and had gradually increased in size, but was not painful or tender. He had had "bronchial asthma" every winter and this was accompanied by chest pains and cough. He stated that he had had malaria, but this had never been confirmed. A biopsy taken from the right upper alveolus was sent to the pathological laboratory.

Clinical impression: Carcinoma of the buccal mucosa.

On Aug. 20, 1942, the pathologist's report presented the following microscopic diagnosis: The section shows a strip of markedly hyperplastic mucous membrane, but at one end of the section the mucous membrane is eroded away by an ulcer and beneath this ulcer there is a mass of darkly staining cells. In this mass there are young fibroblasts, epithelioid cells, polymorphonuclear leukocytes, lymphocytes, eosinophiles and numerous large macrophages. In the cytoplasm of these macrophages and also extracellularly, there are many small organisms which consist of a central, darkly staining body with a clear capsule about it. These organisms are about two to four microns in diameter. The size, appearance and distribution of these organisms clearly indicate that they are Histoplasmas (Figs. 3-5).

Diagnosis: Histoplasmosis of the right upper alveolus.

On Aug. 25, 1942, the patient entered the hospital. On physical examination, the patient did not appear to be acutely ill. He had a small scar on the right cornea. He had an ulcer measuring 3 cm. in diameter, with a ragged edge, on the inner edge of the alveolar border, which extended along the right upper first, second and third molars (Fig. 1). There was a slight discharge from the ulcerated lesion. The blood pressure was 176 systolic and 90 diastolic. There was a blowing systolic murmur. The radial arteries were slightly thickened. The liver was palpable two finger breadths below the costal margin, but was not tender. The spleen was hard, not tender and was palpable four finger breadths below the costal margin.

On Aug. 26, 1942, under general anesthesia, the ulcerated area was removed by cautery with a 1 cm. margin of apparently normal tissue. The molars and premolars were removed and this area also cauterized. The periosteum underlying this area was included in the removal.

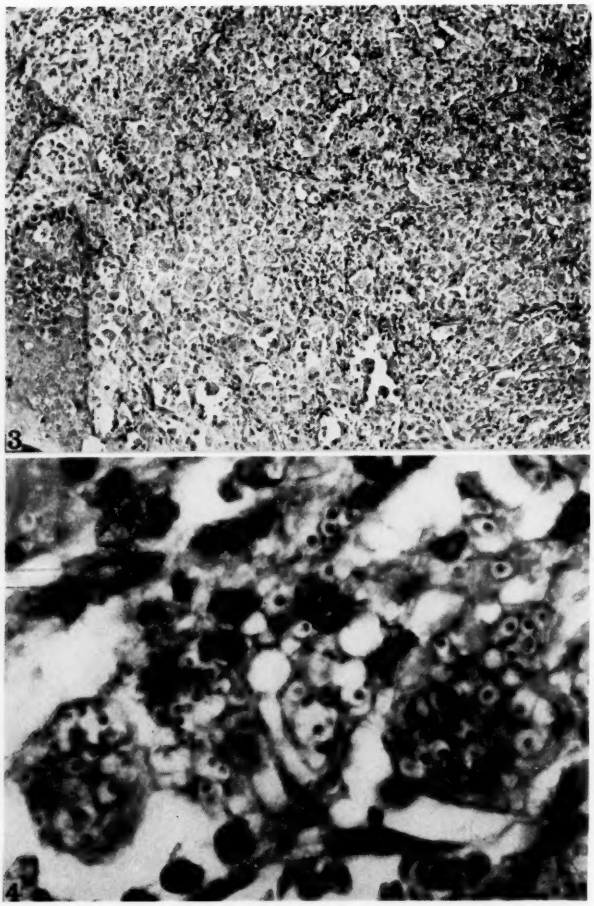

Fig. 3.—Photomicrograph showing section of lesion through right upper alveolus showing marked invasion by reticulo-endothelial phagocytes. X 82.

Fig. 4.—Photomicrograph showing section of mucous membrane showing characteristic cells of Histoplasma engulfed by phagocytes and freely dispersed in tissue. X 1000.

A roentgenogram of the chest made during his hospital stay showed considerable peribronchial infiltration in the lower portion of each lung field. There was some parenchymal infiltration in the right fourth interspace and mild, fungus-like, irregular lung densities. The blood contained the following: 4,880,000 red blood cells; 58.1 per cent hemoglobin; 6,500 white blood cells; 4 eosinophiles; 5 stabs; 67 segmented neutrophiles; and 24 lymphocytes. The urinalysis was essentially normal with a specific gravity of 1.007 to 1.008 and an acid reaction.

On Sept. 9, 1942, the pathologist's diagnosis of a specimen of the tissue removed on Aug. 26 was as follows: The specimen consists of an irregularly shaped piece of tissue measuring about 1.5 cm. in greatest dimension. Tissue removed from the lower gum. The microscopic diagnosis was as follows: The section is made up of connective tissue and mucous glands. About the mucous glands there is a moderate chronic inflammatory infiltrate, but there is no evidence in this section of the organism Histoplasma.

The patient left the hospital shortly thereafter, but reentered on Nov. 12, 1942. There was an area of granular, fungating and ulcerative tissue which extended from the gingival border of the lower incisors, occupying the buccal sulcus, almost to the rim of the lower lip. The lower incisor teeth were loose, tender on pressure, dirty and carious (Fig. 2). The area previously cauterized remained healed. The area of the roof of the mouth posterior to the left incisors was ulcerated. There were no essential changes in the physical examination except that the cardiac murmur was more distinct. The spleen was larger and occupied the upper and lateral fourth of the abdominal cavity. It was hard, smooth and tender. A chest film showed no essential changes.

On the following day, Nov. 13, 1942, under local anesthesia, the entire involved area was destroyed with cautery. The four lower incisors were extracted and the sockets cauterized. The ulcer in the roof of the mouth was destroyed. The blood contained the following: 2,520,000 to 3,360,000 red blood cells; 43 to 55.7 per cent hemoglobin; 3,400 to 4,050 white blood cells. The urine showed from a trace to 2 plus albumin on repeated examinations and the specific gravity was 1.011 to 1.012.

Histologic examination of the removed specimen revealed the organism Histoplasma in abundance in all the tissues including the antral mucosa.

The patient again left the hospital and reentered on Dec. 17, 1942. During the past month his mouth had become very sore and painful. There was marked fetor oris. He had definite pain on drinking and eating and had lost considerable weight. The patient grew weaker and was unable to be up and about except for meals. There were no essential changes in the size of the spleen and liver and no increase in tenderness of these organs. His heart was not enlarged. The systolic murmur at the apex and remainder of the precordium was essentially the same as at the first examination. The chest showed no change in physical or radiographic findings. On Dec. 28, 1942, the blood contained 2,740,000 red blood cells, 50.9 per cent hemoglobin and 4,450 white blood cells.

On Jan. 6, 1943, the patient's temperature rose to 103.2° F. There occurred periods of irrationality and his course went progressively downhill. On the following day, Jan. 7, 1943, the patient died. Autopsy permit was not granted.

HISTORICAL REVIEW

While searching for cases of cutaneous and visceral leishmaniasis in the Panama Canal Zone where he had gone as pathologist, Darling[1] encountered a case of obscure splenomegaly with generalized involvement in a 27-year-old Martiniquan negro showing encapsulated organisms in the tissue sections. This case was reported in 1905 and published in 1906. In 1908 and 1909, two additional cases, somewhat similar clinically, were reported by Darling.[2, 3] The first case was that of a 29-year-old Martiniquan negro and the second of a 55-year-old Chinese shopkeeper who had lived near the Isthmus of Panama for 15 years. The organism was strongly suggestive of the Leishman-Donovan body and had certain characteristics which resembled the organism of kala-azar, yet possessed other features which were different. The microbe was named Histoplasma capsulatum and considered to be a protozoon. In 1906, Strong[4] while working in the Philippines, found Histoplasma-like cells in curettings from a lesion, diagnosed clinically as Delhi boil, on the chest of a 35-year-old woman Filipino. The lesion healed under antiseptic dressings.

In 1912, da Rocha-Lima[5] studied the organism in tissue and noted its resemblance to Cryptococcus farciminosus, the fungus of epizootic lymphangitis in horses. Accordingly, he considered H. capsulatum to be a fungus. This was further elaborated on in 1913.[6] Later, Darling concurred in this belief.

For approximately 15 years histoplasmosis was almost forgotten and no new cases of this disease were described. In 1924, Riehl[7] from

Vienna reported granulomatous lesions of seven years' duration in a white man. These were caused by pathogenic, budding, yeastlike organisms. The patient had a generalized involvement, was treated with arsenic, but eventually died with apparently a generalized involvement and symptoms characteristic of histoplasmosis. Photomicrographs of sections of tissue illustrated typical H. capsulatum. In 1926, Watson and Riley[8] reported a case of undiagnosed splenomegaly in a middle-aged Minnesotan. At autopsy, splenomegaly and pulmonary infection with organic changes similar to those seen by Darling were shown to be due to H. capsulatum. In the same year, Phelps and Mallory[9] reported a case from a native of Honduras who died of primary carcinoma of the liver. The organism was supposedly seen in large mononuclear cells in the alveoli of the lungs. In 1926, Wade[10] reported before the Culion Medical Society "a case of systemic mycosis due to a fungus of uncertain classification."* The patient showed ulcers of the nasal mucosa. Descriptions of the organisms in the tissue and of the lesions correspond to those characteristic of histoplasmosis. In 1931, Crumrine and Kessel[11] published a case of a 42-year-old mulatto with marked gastro-intestinal involvement, in addition to generalized histoplasmosis. In the following year, Müller[12] reported a generalized infection in a 7-year-old Javanese boy. The boy showed general lymph node enlargement with the characteristic fever and emaciation.

The era of intensive study of histoplasmosis can be said to have begun in 1933 when the knowledge of two cases came to light and the causative organism was first cultivated. In that year appeared the title only of a case of a 6-month-old infant with a generalized infection and primary blood disease reported by Dodd and Tompkins.[13] Organisms were demonstrated in smears of pus obtained from the middle ear. DeMonbreun[14] cultivated the organism H. capsulatum for the first time, from the patient, during life and at autopsy, to definitely establish the disease as a mycosis. He reproduced the disease in monkeys and dogs. Hansmann and Schenken[15] likewise reported in *Science* of that year a chronic case of nodular, ulcerative skin lesions from which the fungus was isolated and named Sepedonium. Complete details of the case and of the organism isolated were published in 1934.[16] The patient had a lesion on the buccal mucosa and tongue and on the roof of the mouth. The two strains of fungi were studied by numerous mycologists including Moore, Dodge, Ciferri and Redaelli and later by Howell and Conant and were considered

*Photostatic copy of manuscript loaned through courtesy of Dr. W. A. DeMonbreun, Nashville, Tennessee.

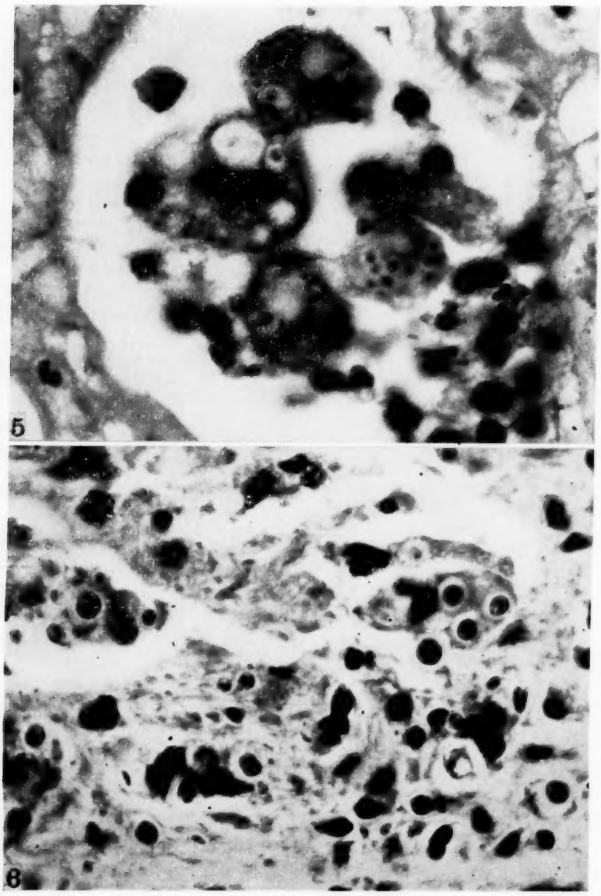

Fig. 5.—Photomicrograph showing Histoplasma engulfed by cells within the superficial layer of the mucous membrane. X 1000.

Fig. 6.—Photomicrograph showing large parasitic cells of Histoplasma in section of prostate. (Moore and Blache case). X 700.

to be closely related by some and identical by others, both belonging to the genus Histoplasma. DeMonbreun established the fungus as being difinitely different from Cryptococcus farciminosus.

In 1938, Negroni[17] published a short note on a strain of H. capsulatum isolated from the first Argentine case of the disease. This was followed by a more detailed study in 1940,[18] including a report on another case of histoplasmosis. One of the cases showed involvement of the soft palate and of the naris. The other, described later in detail by Baliña, Negroni, Bosq and Herrera,[19] had lesions of the trachea and larynx, in addition to generalized histoplasmosis. In 1939 and 1940, many papers on histoplasmosis were published. Agress and Gray[20] reported the case of a 7-month-old boy with generalized histoplasmosis including an ulcer in the buccal mucosa and a mucopurulent rhinitis. Amolsch and Wax[21] reported an 8-month-old white girl with an otitis media. Shaffer, Shaul and Mitchell[22] studied an 11-month-old white girl whose illness was clinically diagnosed as aleukemic leukemia, but on autopsy was found to be generalized histoplasmosis. Clemens and Barnes[23] reported the disease from Kentucky in a 33-year-old syphilitic negress and Reid, Scherer and Irving[24, 25] published a preliminary note on a 38-year-old negro from Virginia who had hoarseness and a cough in addition to diarrhea. Lesions were generalized in this patient. Gunter and Lafferty[26] followed with the report of a generalized infection resembling undulant fever in a 54-year-old white woman from Alabama.

In 1940 also, Williams and Cromartie[27] described the case of a 56-year-old white man from Tennessee with nodal and pharyngeal mucosa involvement. Humphrey[28] published two cases; in one the patient complained of dysphagia and hoarseness with an ulcer of the palate presumably due to a Vincent's infection. The other patient had a generalized infection and mycelial elements were found in a nodule of one of the lungs. In this paper, Humphrey established the name "reticulo-endothelial cytomycosis" as a substitute for histoplasmosis. Meleney's fine review of the disease appeared in 1940,[29] listing 13 unpublished cases and 19 published, some of which have since appeared in print and others are apparently in press.

Since Meleney's review of 32 cases, the number has more than doubled in three years. Some of the publications since the review include numerous interesting facts. Brown, Havens and Magath[30] reported a case with naso-oral cavity involvement. Particularly evident were cough, sore throat and ulcers of the hard and soft palate and of the uvula. De Almeida and Lacaz[31] isolated Histoplasma from skin nodules and from the sputum of patients in Brazil. Anderson, Mich-

elson and Dunn[32] reported the case of an 8-month-old white girl with a clinical diagnosis of aleukemic leukemia. There were present an otitis media, diarrhea and ulcers of the intestines. Meleney[33] reported two cases of pulmonary histoplasmosis, both being associated with proven tuberculosis of the lungs. Villela and Pará[34] found Histoplasma in a liver puncture, after death, in a 3-year-old mulatto child from Brazil. Derry, Card, Wilson and Duncan[35] reported a case which resembled kala-azar or lymphosarcoma and apparently originated in France. There were found submental and pre-auricular sinuses with large bowel and pelvic involvement. Key and Large[36] reported an interesting case of joint histoplasmosis with the organism present in the synovial membrane of the left knee, the whole resembling tuberculosis. Palmer, Amolsch and Shaffer[37] reported a case with mucocutaneous involvement resembling leishmaniasis. Lesions were found in the larynx, vocal cord and hypopharynx as well as on the tongue, palate and mucous membranes and other organs. Simson and Barnetson[38] reported a case from South Africa with nodules and ulcers in the tongue, gums and lips. Dean[39] reported histoplasmosis of the larynx, epiglottis, false and true cords, which resembled carcinoma, in a 41-year-old white man from Missouri. Van Pernis, Benson and Holinger[40] published a case of laryngeal and systemic histoplasmosis in a 65-year-old man from Chicago. Broders, Dochat, Herrell and Vaughan[41] reported a case of mitral valve involvement which resembled subacute bacterial endocarditis. A similar case has since been seen by the Department of Pathology, Washington University School of Medicine, and reported.[42]

There are in addition a number of cases of histoplasmosis, some of which show involvement of the ear, nose or throat. These will be considered in the accompanying tables listing all cases, as far as we have been able to determine, showing lesions of these anatomic regions. (Tables 1 and 2.)

ETIOLOGY

The organism responsible for reticulo-endothelial cytomycosis or histoplasmosis, as first described in tissue by Darling, was named Histoplasma capsulatum because it appeared very much like a protozoon. Da Rocha-Lima studied the organism as it appeared in tissue sections and found that it multiplied by elongation and fission (budding) and this led him to believe that the microbe was closely related to, if not identical with, Cryptococcus farciminosus, the cause of epizootic lymphangitis in horses.

The true fungous nature of the organism, however, was not confirmed until the publications of DeMonbreun and of Hansmann and

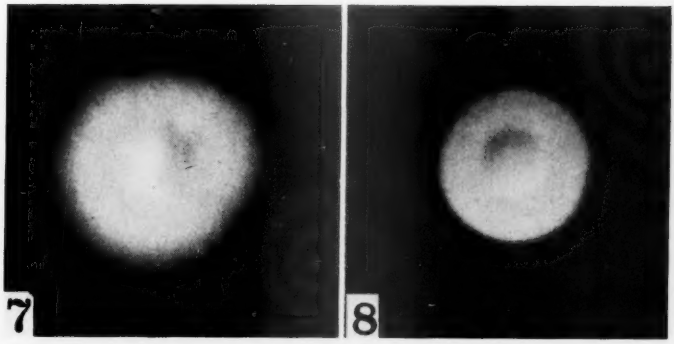

Fig. 7.—15-day-old culture of Histoplasma capsulatum grown on Sabouraud's glucose agar. X 1.

Fig. 8.—15-day-old culture of Histoplasma pyriforme grown on Sabouraud's maltose agar. X 1.

Schenken. DeMonbreun isolated his strain of H. capsulatum from the blood stream two days before death and from the spleen postmortem of the patient of Dodd and Tompkins. He proved the pathogenicity of the fungus by inoculating experimental animals (dog, monkey and mouse), producing the systemic disease and recovering the organism.

Hansmann and Schenken isolated their strain of Histoplasma in the same year from a 43-year-old white man who had a refractory skin ailment for approximately 16 years. The fungus, named at first Oidium and then Sepedonium, was grown from thick, red, hard and scaly skin nodules and from an enlarged lymph node. This strain was passed through the dog and cat, reproducing the disease.

Both strains were studied by Moore[43, 44] and because of variations in size and rate of growth and because of some modification in morphology one was named as a new species.

Histoplasma is seen in tissue usually in reticulo-endothelial phagocytes, in monocytes, alveolar cells, epithelial cells as of the buccal mucosa (Figs. 3-5) or intestinal mucosa, in bone marrow and in peripheral blood or freely distributed in affected tissue. It consists of a simple or budding, round or oval, yeastlike cell approximately one to four microns in long axis, usually three microns. The organisms are surrounded by a clear, refractile and non-staining capsule which equals about one-sixth the total diameter of the cell. The

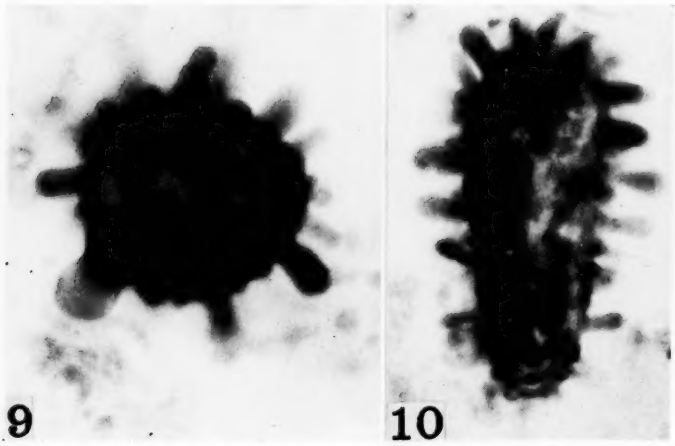

Fig. 9.—Photomicrograph showing tuberculate or spiny, spherical cell of Histoplasma. X 2300.

Fig. 10.—Photomicrograph showing tuberculate or spiny, pyriform cell of Histoplasma. X 2300.

cytoplasm is nonhomogeneous, granular and may be vacuolated with the nuclear material usually eccentrically located near one pole of the cell in the form of a crescent. This gives the fungus the appearance of a signet ring. In addition to the small cells, the fungus described as H. pyriforme shows larger cells, spherical in appearance, measuring up to five or six microns in diameter, some larger.

Histoplasma is easily grown on routine, fungous, artificial mediums. (Figs. 7-8). These include Sabouraud's maltose or glucose agars and potato-dextrose medium. It may also be cultivated on two per cent dextrose agar as well as on mediums containing ten per cent rabbit or human blood. The organism is an aerobe, but it may grow in partial anaerobiasis. DeMonbreun, Ciferri and others have shown that when inoculated in blood agar slants that were sealed and incubated at 37° C., the yeastlike form is grown and may be maintained when subcultured at three to five day intervals in the same medium under the same conditions. When grown aerobically, with the tubes not sealed, at room temperature, the mycelial form of the fungus develops showing aerial hyphae. Under aerobic conditions at room temperature, the culture will develop in approximately three to ten days.

In culture, Histoplasma shows septate hyphae, 1 to 5 microns in diameter, sometimes showing racquet mycelium: the chlamydospores are 3 to 10 microns in diameter, single or in chains, intercalary or lateral, sessile or pedicellate, rarely terminal. The conidia are lateral, spherical or pyriform, 2 to 8 microns in diameter. The large cells are spherical or clavate, 5 to 18 microns in diameter, smooth and thick-walled at first, becoming pitted, then spinose and finally tuberculated (Fig. 9). The tubercles are variable, often resembling germ tubes, but are functionless. H. pyriforme shows many pyriform tuberculated cells, 6-12x12-26 microns, usually 10x22 microns (Fig. 10).

The two strains of Histoplasma, H. capsulatum (DeMonbreun isolate) and H. pyriforme (Hansmann and Schenken isolate) have since been studied by several investigators (Radaelli and Ciferri[15-50] and Howell[51]). They believe both species to be identical. Ciferri, Radaelli and Visocchi[52] created the family Histoplasmaceae of the superfamily Atelosaccharomycetaceae, for the genus, placing it among the anascosporogenous yeasts, whereas Conant[53] places the genus in the Moniliaceae of the Fungi Imperfecti on the basis that it simulates Sepedonium.

The finding of the large cells of Histoplasma in the tissues by Hansmann and Schenken (which was partially instrumental for creating the species *H. pyriforme* by Moore) has been explained by Meleney on the basis that "it is possible that organisms which show a special affinity for the skin or which develop as secondary invaders in the lungs may have different cultural characteristics from those producing visceral lesions." Large parasitic cells in addition to the small cells were seen by Moore in tissue sections of the prostate in an unreported case of Moore and Blache (Fig. 6).

The role of the large tuberculated structures termed chlamydospores, aleuriospores or stalagmospores by some and ascus-like by others, have caused considerable discussion. Since such a structure serves as a means of classifying the fungus, its true nature should be determined. Conant assumes that they are aleuriospores, giving rise to one or at the most two germ tubes which branch to give the appearance of multiple germ tubes. DeMonbreun and Moore, on the other hand, have noted numerous germ tubes arising from this tuberculated structure. The latter observation leads one to suspect that it is ascus-like and not an aleuriospore. To further substantiate the view that these large, tuberculated structures are ascus-like in nature, the chorio-allantoic membrane of developing chicks were inoculated by Moore. The large cells became converted into many small yeastlike

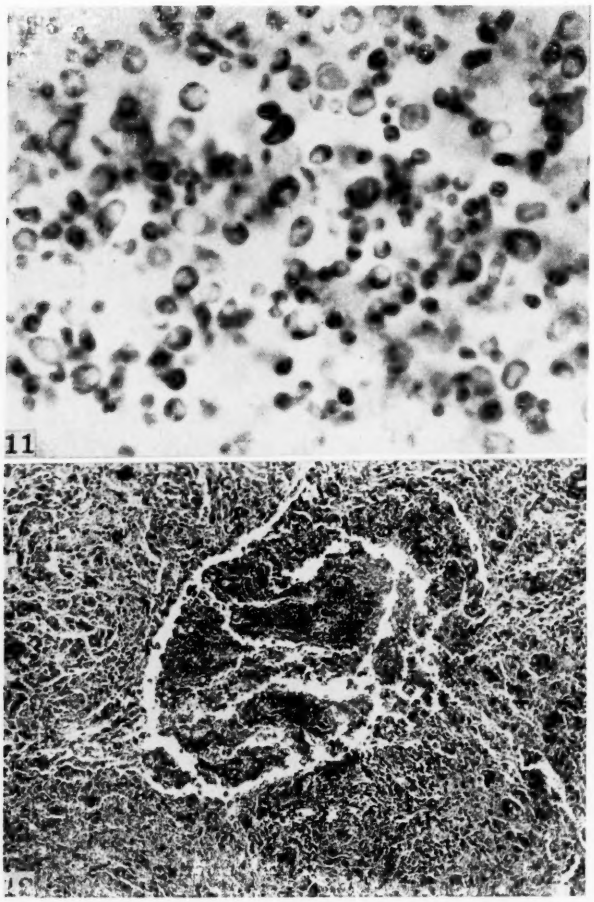

Fig. 11.—Photomicrograph showing yeastlike cells of Histoplasma capsulatum grown on the chorio-allantoic membrane of the developing chick. X 1015.

Fig. 12.—Photomicrograph showing necrotic nodule with proliferating center in section of prostate. (Moore and Blache case). X 98.

cells (Fig. 11). Since each cell is capable of germinating to produce a hypha and subsequently a mycelium, thus necessitating the presence of the essential anlage for germination, it is difficult to hold to the view that the tuberculated cell is an aleuriospore or a chlamydospore. It is especially difficult to consider these cells as aleuriospores because aleuriospores are uninuclear. Consequently these structures must be regarded as ascus-like, probably of a degenerate nature.

EPIDEMIOLOGY AND GEOGRAPHICAL DISTRIBUTION

As far as can be determined, histoplasmosis is not an epidemic disease. The organism, like many other fungi, may be a saprophyte in nature, but this has not been proven to a satisfactory degree. DeMonbreun found H. capsulatum to be the cause of a spontaneous infection in a dog.[54] The organism was identified in culture and its pathogenicity proven by transmitting the infection to young dogs parenterally and by mouth with originally infected tissue and with cultures of the fungus. Organisms like Histoplasma have been found in diseased tissues of mice[55] and the ferret.[56]

The mode of transmission of the disease is of great interest. The fact that the disease has been found in the dog, ferret and mouse should make one suspect these animals as carriers of the fungus. Animals are well known as carriers of fungi, especially of the dermatophytes which cause ringworm in children and occasionally in adults. In addition, since histoplasmosis has been reproduced experimentally in dogs, mice, rats, monkeys, rabbits and guinea pigs by several investigators, one should emphasize the possibility that these animals might be carriers. In addition to laboratory animals, the chorio-allantoic membrane of developing chicks has been successfully inoculated to reproduce the disease in that structure.[57]

The portal of entry has been largely a matter of conjecture, especially since it is difficult to establish the seat of the infection. In some cases, the lesions have been confined almost wholly to the lungs. This suggests the respiratory tract as the route of infection. In several of the systemic fungous infections, this seems to be a plausible method for the organism to gain entrance to the body. Many of the lesions of the oral cavity appear to be primary and this speaks in favor of the inhalation method. Also, gastro-intestinal lesions serve only to emphasize the oral cavity as the portal of entry. Cutaneous lesions may likewise be a possible route whereby the fungus can spread through the subcutaneous tissue to become systemic. Since fungi have been found in the discharge from patients with otitis media,

usually infants, it has been suggested that the ear may also serve as a portal of entry.

Histoplasmosis is rapidly becoming a disease of world wide importance. To date, cases have been reported from widely distributed points in the United States, from the Panama Canal Zone, the Philippines, Honduras, Java, Argentina, Brazil, Austria, France, South Africa, perhaps Mexico and no doubt other countries.

As far as can be determined, histoplasmosis respects neither sex, color, age or nationality. Rich and poor alike may be affected. No one seems to be immune. A review of the known cases shows that both males and females may be infected with Histoplasma, the number of males being greater. White, negro, mulatto and Chinese have suffered with the disease. The ages have varied, with approximately one-fourth of the published cases occurring in infants, the youngest being three months (Rhodes, Conant and Glesne[58]). The oldest case published is that of Meleney, a man 69 years of age. However, Sherwin's unpublished case was of a 71-year-old man and we feel sure that there are others that may even be older.

PATHOLOGY

The gross pathological lesions seen postmortem depend very much on the organ involved and the stage of the infection. In general, there has been enlargement of the spleen and liver accompanied in most cases with tubercle-like nodules varying in size and simulating miliary tuberculosis. The liver may become atrophied, showing cirrhosis. The superficial and deep lymph nodes have usually been found to be enlarged. The peribronchial lymph nodes also show ulcerated tubercles. The adrenals, when involved, have shown caseation necrosis, again simulating tuberculosis. The skin has shown a variety of lesions including papules, papillomata, suppurative processes with many draining lesions, scaling nodules which were infiltrated, ulcerations, purpuric spots and jaundice. The lungs have shown abscess cavities associated in some cases with tuberculosis, patchy consolidation and small hemorrhagic pale nodules appearing like miliary tubercles. Areas of granulation and of necrosis are very common. Ulcerative lesions of the ileum are not uncommon. Gray or white nodules representing pseudotubercles may be found in both the small and large intestines, with ulcers and erosion of the mucosa and the submucosa. The pleurae show fibrous adhesions or a fibrinopurulent exudate. The kidneys, when involved, have shown edema with small hemorrhages. Small gray nodules have been seen on the thymus and the pancreas. Granulomatous lesions are not uncommon. Most in-

ternal organs have been affected either with nodules or ulcers. The brain and meninges have also been involved as well as the prostate. In one case, the synovial membrane of the left knee has shown an abscess cavity which was tuberculous in appearance. The heart has been involved with vegetations on the mitral and aortic valves. Of chief interest here is the fact that the naso-oral cavity has shown verrucous, nodular, ulcerative and granulomatous lesions on the tongue, epiglottis, vocal cords, larynx and tonsils. The hard and soft palate and the gums have likewise shown ulcers and verrucous lesions. The ears in some cases have developed suppurative, draining processes usually originating in the middle ear.

Microscopically, the picture is quite similar for most lesions. There are seen necrotic areas which have a central proliferation with loss of cellular and consequently tissue structure (Fig. 12.) The necrotic debris presents a granulomatous picture. Distributed throughout the granuloma can be seen fibrous tissue, small foci of necrosis and large numbers of macrophages containing the small, yeastlike cells of Histoplasma. Giant cells of the Langhans or foreign body type may also be seen, as well as lymphocytes, plasma cells, eosinophiles and an increased number of capillaries. Many of the small foci of cells are made up of lymphocytes and monocytes with polymorphonuclear leukocytes. Polymorphonuclear leukocytes are generally few in number, but may occasionally be found as a heavy infiltrate.

Of chief importance, histologically, is the location and distribution of the fungi. These are present usually in large numbers within large mononuclear cells of the reticulo-endothelial system (Figs. 3-4). In general, the organisms may be found widely distributed in those organs containing necrotic lesions or reticulo-endothelial cells. Because of this, Humphrey changed the name of the disease, perhaps justifiably, to "reticulo-endothelial cytomycosis." However, the organisms may also be found in reticulum cells and cortical cells of the adrenal with little inflammatory cell reaction. In the bone marrow, the trabecular spaces are filled with lymphocytes and mononuclear cells which engulf the organisms. In smears of the peripheral blood, mononuclear and reticulum cells are seen, gorged with organisms. The fungus may also be phagocytized by epithelial cells, not only by those of the adrenal cortex, but also by those of the intestinal and buccal mucosa and by those of the epithelium of the skin (Fig. 5). In the liver, the Kupffer cells may take up the parasite.

The distribution of the organism does not, as a rule, follow a set pattern. Usually it is present in large numbers at the edge of a nec-

rotic lesion and lacking in the actively proliferating tubercle-like granulomatous nodule. However, it may also be present in extremely large numbers in such a tubercle. In some organs rich in lesions, there may be extremely few yeastlike cells whereas in other organs seemingly little affected grossly, the fungi may be overabundant. Even in the same lesion, Histoplasma may be found in large numbers in one part of the affected tissue and absent from the remainder. The case presented here is an example of that. Histoplasma is generally found in varying numbers in phagocytes, but it may also be distributed freely within the area of granulation tissue, perhaps because the phagocytes have been few in number and unable to engulf them.

CLINICAL MANIFESTATIONS AND SYMPTOMATOLOGY

Histoplasmosis is characterized by a number of clinical signs and symptoms depending on the organ or organs involved. Lesions may be localized to one anatomic region or they may be generalized to involve practically the entire system. Usually, however, the patient dies as a result of a generalized infection. The chief signs in such cases are anorexia with resultant emaciation which may be severe or moderate, asthenia, anemia occurring usually in the terminal stage, leukopenia which may be marked, irregular pyrexia, splenomegaly and in many cases hepatomegaly. There may be generalized pain in the back, joints, muscles or localized pain such as epigastric or lower abdominal. The latter may be accompanied by vomiting and diarrhea. Pain in the chest may occur along with a cough, hoarseness, sore throat and difficulty in breathing.. Headaches have also been known to occur. The enlarged spleen may be lacking in some cases; however, postmortem findings in generalized cases invariably reveal the fungi in this organ. In a few cases the anemia, splenomegaly and leukopenia were lacking. There may be a systemic febrile condition with a septic temperature curve accompanied by an enlarged spleen and liver not unlike the characteristics of kala-azar. The superficial lymph nodes generally, and the deep nodes occasionally, become involved and enlarged, the former presenting a picture not unlike Hodgkin's disease, lymphosarcoma or leukemia.

Like other mycotic infections which tend to become systemic and present a granulomatous picture, histoplasmosis can be divided into several distinct types. It must be added, however, that although specific organs may be solely involved, the infection spreads rapidly and becomes more or less generalized systemically at the time of death. This has been shown to be true in most of the cases that have been examined postmortem. On the basis of location of lesions, there-

fore, histoplasmosis may be divided into two main groups: cutaneous and systemic.

Cutaneous histoplasmosis. Histoplasmosis of the skin may be primary or secondary to a systemic infection. Clinically the lesions may be papules, with a raised periphery, papillomata, ulcers set in a thickened skin, suppurative processes with exudate, scaling nodules which are hard and infiltrated and purpuric spots. Skin lesions rarely remain as the sole site of involvement. When secondary to, or associated with, a systemic infection the symptoms characterizing the general infection are present.

Mucocutaneous type. This type is closely associated with the cutaneous type. The lesions are found occurring at the mucocutaneous junction, spreading to the adjacent skin on the one hand and to the mucous membranes on the other. The lesions are chiefly ulcerative, occurring on the eyelid, lip, penis and parianal region and are usually covered with a crust, have little peripheral inflammation and are not very indurated. This type may closely resemble mucocutaneous leishmaniasis.

Otitic type. Infection of the middle ear has occurred in several cases. All the symptoms of otitis media are present. These are pain, deafness, tinnitus, vertigo and fever. The infection is accompanied by exudate which may be purulent, the organisms being demonstrable in smears therefrom. Histoplasmosis of the external auditory canal has been noted. Lesions of the ear may be primary or secondary and perhaps when primary serve as a focus of infection for the systemic spread of the disease.

Naso-oral type. This type may or may not be a continuation of the mucocutaneous type. In a few cases when infection involved the lips there has likewise been an infection of the naso-oral cavity. The lesions usually are found to be granulomatous in character. Histoplasmosis when found in the oral cavity may produce various types of lesions and involve from one to practically all the structures present. Lesions consist of nodules usually present on the tongue, gums and lips, some of which may appear like polyps, simulating a carcinomatous process. The nodules usually ulcerate. Nodules extend into the pyriform sinus and they may be found on a thickened epiglottis, larynx or pharynx. Ulcers, however, seem to predominate and these may be found on the hard and soft palate, gums, tongue, epiglottis, uvula, true and false cords and various other structures. A verrucous or vegetating mass may likewise be found in the oral cavity. The buccal mucosa is most often involved, usually showing an ulcerous lesion which tends to spread to the gums, palate, tonsils and fossa and

then to the larynx. In a spreading lesion of this type there is invariably an exudate which covers it, gray or pinkish-gray in color. On occasions it has been noted that the vocal cords and larynx were markedly hyperemic with only slight roughening of the cords, but no ulceration. It can be truthfully said that to list the various structures of the oral cavity that have been involved in one case or another would be to list all the structures of the oral cavity.

It is noteworthy that in most of the cases of oral histoplasmosis, the oral hygiene has been extremely poor. Marked pyorrhea alveolaris was present and the teeth were dirty and carious. The case presented in this paper illustrates this well.

As a result of the various lesions of the oral cavity, the patient usually complains of weakness, sore throat and difficulty in swallowing. A cough is invariably present as well as hoarseness which may develop into aphonia.

Involvement of the nasal structures is usually considered as part of the oral involvement. Ulcers of the nasal mucosa occur sometimes as an extension from lesions of the mouth. The nares may show a granulomatous lesion not unlike a small tumor-like growth. The growth may involve the nasal septum and in a few cases has caused a perforation of the septum. The consequences of such an infection may be a mucopurulent rhinitis, as has been noted in one case.

Systemic histoplasmosis. From the oral cavity, the infection usually spreads to various parts of the body including the pulmonary system, gastro-intestinal tract, genito-urinary tract, including kidney and prostate, adrenal, superficial and deep lymph nodes, spleen, liver, pancreas, pleura, cerebrospinal system, including brain and meninges, heart, thymus, bone marrow and bone and joint.

Pulmonary type. Histoplasmosis of the lungs has occurred in practically all of the cases that have been examined postmortem. Disease of the lungs may be primary or secondary to infection elsewhere, usually extending from the bronchi. The parasite evidently invades the alveoli where it is taken up by phagocytes with an infiltration of epithelial cells. Distributed throughout the lung tissue there can be seen foci of accumulated cells in the form of tuberculous nodules, discrete or confluent, some showing necrosis while others may show caseation. Interstitial lesions also occur, showing microscopically lymphocytes and plasma cells and a few epithelioid cells. The pseudotuberculous nodules may also be found extending into the surface of the lungs and from there the organism easily infects the pleura, producing tubercles of the same nature.

Histoplasmosis of the lungs in many respects is similar to tuberculosis. Pathologically the lesions simulate miliary tuberculosis. In several cases there has been an associated tuberculosis. This was proven in two cases of histoplasmosis localized to the lungs as described by Meleney. In one of the two cases, Meleney found cavitation to be present, unaccompanied by tuberculosis.

Clinically, patients affected with pulmonary histoplasmosis show an irregular fever, pain in the chest, cough, expectoration of sputum within which Histoplasma can be demonstrated, night sweats, emaciation and other features such as râles, hemoptysis, signs of pneumonia and bronchopneumonia. Roentgen examination in cases of pulmonary involvement has brought back reports indicating possible tuberculosis with pulmonary fibrosis.

It has been suggested that the respiratory tract, as in other mycotic infections such as blastomycosis or coccidioidomycosis, may serve as a portal of entry. Likewise, tuberculous cavities may be primary foci of infection with Histoplasma as a secondary invader in these areas.

Gastro-intestinal type. Involvement of the gastro-intestinal tract has occurred in a fairly high percentage of the reported cases. In several of these cases, symptoms referable to the gastro-intestinal system have been prominent factors of the disease. From a diagnostic standpoint it is important to differentiate histoplasmosis from other infectious processes of the gastro-intestinal tract. Chief among these perhaps is ulcerative enteritis as shown in the case reported by Henderson, Pinkerton and Moore.[59] In all of the cases showing lesions of the digestive system there has likewise been found, on postmortem examination, a generalized infection. Microscopic examination of necrotic material has revealed involvement of the ileum, colon, jejunum, pylorus, bowel, large and small intestine, cecum, rectum, and other regions, in the form of nodules, ulcers and granulation tissue with erosion of the mucosa and submucosa.

Clinically, the symptoms have consisted of diarrhea, either mild and transient or chronic, vomiting, colitis, epigastric pain, abdominal pain with distention and tenderness. However, the characteristic symptoms of fever, emaciation, weakness, loss of appetite and anemia are usually present as well. The stools have been described in some cases as liquid and whitish, without gross blood. A diagnosis of amebic dysentery and ulcerative colitis was made in one case on the assumption that the organisms seen in the macrophages in a stool examination were amebae.

Genito-urinary type. Histoplasmosis of the genito-urinary tract is not an uncommon finding. The kidneys have been involved on numerous occasions, varying from mild edema to necrosis. The prostate has shown the infection in at least two cases, one being an unreported case of Moore and Blache. The penis has been infected in what has been described as the mucocutaneous type. The testes were involved in the case of Van Pernis, Benson and Holinger.[40] Along with the kidneys, the adrenal glands have been infected in many of the cases.

Bone and joint type. This type as yet is rare, with only one reported case, that of Key and Large.[36] The fact that the clinical manifestations of this type of the infection are sufficiently different makes it advisable to classify it as a separate group.

The patient was a 47-year-old white man whose left knee was enlarged, apparently inflamed, with the synovial cavity distended, and the knee joint contained fluid. The clinical impression was infectious arthritis. Roentgenograms of the knee and of the chest were taken and the joint showed thickening of the soft tissue, atrophy of the bone structure. The chest showed areas of almost complete opacity. No diagnosis was made. When seen later by Key and Large, a diagnosis of tuberculosis was made. Second roentgenograms were made of the knee and these showed increased density of the synovial tissues, increased atrophy of the bone, narrowing of the joint space and marked broadening and erosion of the margins on the intercondylar notch. Pus was aspirated from the joint and injected into a guinea pig on the basis that it was a low grade pyogenic infection or a tuberculous process. Because of a negative report on the guinea pig inoculation, the leg was amputated. On the tenth postoperative day, the patient died and a diagnosis of right lower lobe pneumonia, complicated by right heart failure and meningismus was made by the attending physician. Autopsy was not permitted.

Gross examination of the amputated leg showed an enlarged knee with a large abscess cavity in the synovial tissue filled with thick gray purulent material. The abscess extended into the calf of the leg. The articular bone surface showed a great deal of erosion and necrosis, resembling advanced tuberculosis. The synovial tissues were also markedly affected, being thickened and covered with a grayish-white exudate. Microscopic examination of the affected tissue revealed Histoplasma and the diagnosis of histoplasmosis was established. It is quite likely that the chest lesions were also those of histoplasmosis.

Clinically, on movement, the knee joint was painful and resulted in muscle spasm. There was a moderate increase in local heat of the tissue.

The bone marrow has been involved in several cases. In some of these, the trabeculae showed erosion with an invasion by phagocytic cells.

Other types. The involvement of other organs is usually a result of the spread of the fungi to these organs. In some cases, however, the localization of the lesions to a particular organ has led to much speculation as to the diagnosis. An example of this is the involvement of the heart. Heart lesions have been noted in several cases, but in most instances it has been part of a generalized systemic histoplasmosis. The organism has been found phagocytized in the cardiac musculature. In the case published by Broders, Dochat, Herrell and Vaughan[41] the organism produced a vegetative endocarditis of the mitral valve. This was part of a generalized systemic infection. In a second case, published as a case report from Barnes Hospital by Wood and Moore,[42] the chief symptoms were those of a heart lesion. Histoplasma had produced a vegetation on the mitral valve in addition to involvement of the cusps of the aortic valve. The clinical signs pointed to a diagnosis of bacterial infection. Postmortem examination of other tissues revealed infection of the kidneys, spleen, liver, pancreas and brain. Since there was a generalized infection, the usual features of histoplasmosis were present.

Brain involvement has been found in a few cases. The diagnosis was determined by microscopic examination of tissue sections. In Darling's second case, headaches were an important factor, along with the characteristic signs of the disease.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

The clinical diagnosis of histoplasmosis is not an easy matter. Its similarity to many diseases is well exemplified by the large number of clinical diagnoses and impressions. Cutaneous histoplasmosis should be differentiated from such diseases as Delhi or Oriental boil as described by Strong,[4] from leukemia cutis, dermatitis exfoliativa, especially of the pustular, scaly type, cutaneous leishmaniasis, blastomycosis and tuberculosis cutis. In infantile cases with cutaneous lesions, impetigo should be ruled out. The mucocutaneous type resembles very closely mucocutaneous leishmaniasis. Lesions on the lips extending into the oral mucosa may resemble noma. Ulcerative lesions on the penis as described by Palmer, Amolsch and Shaffer[37] may re-

semble syphilis. Histoplasmosis of the ear may have all the characteristics of a bacterial or some fungous otitis media. In the nasal cavity the similarity to papillomata is apparent and perhaps also to rhinosporidiosis and to leishmaniasis. Oral lesions especially when ulcerous and involving the buccal mucosa, tongue and larynx resemble closely carcinoma and blastomycosis. In these cases, the presence of nodules, miliary in size and distributed over the surface of the oral structures, may be mistaken for tuberculosis.

The various features of histoplasmosis such as anemia, splenomegaly, hepatomegaly, continuous or irregular pyrexia, so often present in the systemic or generalized forms, may lead one to suspect kala-azar or other infectious processes of which miliary tuberculosis is usually suspected as an offender. The anemia might be interpreted as Addison's disease and with the enlarged liver and spleen, the diagnosis of Banti's or Gaucher's disease would be entertained. In a number of cases the anemia, leukopenia and lymph node enlargement have been responsible for a clinical diagnosis of aleukemic leukemia, lymphosarcoma, lymphadenoma and aplastic anemia. Lymph node enlargement when localized has been mistaken for Hodgkin's disease.

The pulmonary form of the disease usually suggests chronic pulmonary tuberculosis, especially as viewed in roentgenograms. Often, the symptoms are those of a pneumonia or bronchopneumonia. Gastro-intestinal histoplasmosis should clearly be differentiated from ulcerative colitis, tuberculous enteritis, regional ileitis, amebic dysentery or some bacillary dysentery. Histoplasmosis of the kidney can simulate many of the common renal lesions. The case of Key and Large with involvement of the knee joint, closely resembled tuberculosis. Heart lesions have been diagnosed as bacterial endocarditis. Bacterial myocarditis should also be ruled out. As additional differential diagnoses, in cases of continued unexplained fever with other symptoms such as anemia and leukopenia, conditions such as blood dyscrasias, undulant fever and malaria should be ruled out.

It is obvious that the diagnosis of histoplasmosis, clinically, is not an easy matter. Furthermore, it is clear that in order to establish the correct diagnosis it is essential that the organism be either demonstrated or cultivated. The demonstration of Histoplasma can be accomplished in various ways. In well advanced systemic cases, the organism can be seen in thin smears of the peripheral blood stained with Wright's stain or with supravital dyes. The smears should not be too darkly colored. Meleney suggests using dehemoglobinized thick drops comparable to those used for diagnosing malaria. The fungous cells are quite characteristic, even in smears, as round to oval

yeastlike cells with the nucleus eccentrically located near one pole of the organism. The nucleus is often in the form of a signet ring. Surrounding the cell is a clear, nonstaining capsule or membrane. These organisms can be seen in varying numbers in large monocytes or phagocytes and occasionally in neutrophiles. Smears from bone marrow as well as spleen, liver or lymph node punctures may be resorted to in order to arrive at a diagnosis. Biopsy from accessible lesions such as occur in the oral cavity, palpable lymph nodes and on the skin has proven valuable as a diagnostic measure. Smears from sputum, stools, urine may likewise yield the organism. Histoplasma has been isolated from the sputum of a patient with pulmonary involvement. Lesions of the gastro-intestinal tract and those of the genito-urinary tract should yield fungi in the stools and urine respectively.

The cultivation of the causative fungus from infected tissue or blood is usually the most reliable diagnostic method. Methods for cultivation have been described in the section on etiology.

As a futher aid in diagnosis, methods devised independently by Zarafonetis and Lindberg[60] and by Van Pernis, Benson and Holinger[61] have been advocated. The methods of the former two authors consist first of passing a sterile filtrate through a Berkefeld "N" filter of a seven weeks' growth of the mycelial form of H. capsulatum grown in William's synthetic medium. The second antigen is made up of a suspension of approximately one billion yeastlike organisms per cubic centimeter grown on blood agar slants, suspended in physiological saline containing 0.5 per cent formalin. After one week, the organisms are repeatedly washed in saline and suspended in 0.2 per cent solution of the methyl ester of parahydroxybenzoic acid in physiologic saline. The test dose is 0.1 cc. intradermally.

The latter authors use the filtrate of a dextrose broth culture and secondly the acetone precipitated substance of a broth filtrate obtained by treating the filtrate with three volumes of acetone and redissolving the precipitate in saline. This is also injected intradermally to obtain an erythematous wheal.

Such tests, if proven valuable, should be of great benefit in obtaining an early diagnosis in obscure cases of histoplasmosis.

PROGNOSIS AND TREATMENT

Histoplasmosis is invariably a fatal disease. Extremely few cases have been reported as remaining alive. Since the disease becomes systemic in due course of time, in spite of present methods of treat-

ment, it is quite possible that a follow-up in these rare cases would disclose a fatal termination. As diagnosis is often not made until shortly before death, it is possible, however, that undiagnosed cases have resulted in spontaneous cure. The chief aim at the present time is to be able to recognize early cases of histoplasmosis so as to try to effect a cure before generalized involvement.

Treatment for this infectious disease has been varied, in the main symptomatic, and partially ineffectual. The use of potassium iodide by mouth or sodium iodide intravenously have not been satisfactory. Neoarsphenamine has likewise been of no value in this disease. Roentgen ray therapy has been tried in several cases without apparent benefit. Many chemotherapeutic agents have been tried, with some alleviation of symptoms, but in general they have failed to bring about a cure. Of the antimony preparations such as antimony tartrate, fuadin, the trivalent organic compound and the pentavalent compound, neostam, have been employed with some benefit. In the case of Strong, curettage followed by the application of antiseptic dressings apparently brought about a cure. However, the case was not followed for a sufficiently long time to verify the cure. A long list of agents have been tried in combating histoplasmosis. These include arsenic, anti-leprosy treatment, pentnucleotide and liver extract, bismuth, sulfanilamide, atabrine, prontylin, Fowler's solution, potassium arsenite, quinine, vitamins, sulfathiazole, sulfapyridine, emetine, sulfarsenal and others. The use of radium (radon seeds) on an ulcer of the tongue produced a local clearing, but the patient died of an apparently generalized systemic infection. Surgical excision, if not too extensive and when used on an early lesion, may be beneficial. In the case reported here it proved of some value for a short period of time.

The outlook at the present time is not hopeful. Perhaps the ability to produce a generalized systemic disease in animals, as has already been done, may suggest more specific and effective means of combating the disease.

REVIEW OF CASES OF HISTOPLASMOSIS WITH EAR, NOSE AND THROAT INVOLVEMENT

To date, we have been able to gather from the literature and from personal communications, including the case reported here, 22 cases of histoplasmosis with lesions of either the ear, nose or throat, separately or together, with or without lesions in other organs of the body. This makes approximately 30 per cent of the cases of histoplasmosis, published and unpublished. With the exception of 3 cases,

that unreported by Wade (1926) and those reported by Dodd and Tompkins (1933-1934) and by Hansmann and Schenken (1933-1934), the cases have occurred between 1939 and the present time. From a geographic standpoint, it is of interest that the reports have come from the Philippines, Cape Province, South Africa, Iowa, Texas, Virginia, Illinois, New York, Ohio, 2 from Argentina, 3 from Tennessee, 4 from Missouri and 5 from Michigan. One was a Filipino, 1 a negro and the remaining 20 patients were white. Three cases were females and 19 were males. Four cases were infants 6 to 8 months of age and 18 were adults varying in age from 18 to 71 years, with the larger number of cases occurring in the so-called middle aged group.

From a clinical standpoint, it is of interest that the duration of the disease, from the earliest known symptom to approximately the time the patient came under medical attention or to the time of death, varied from 5 weeks to 15 years. Fever was present in most of the cases, but was irregular or remissive. Most of the patients showed a weight loss varying from a slight degree of emaciation to a known weight loss of from 20 to 40 pounds in six months and in one case of 108 pounds in two years. In those cases with throat involvement, difficulty in swallowing was an important factor. Leukopenia was usually noted at one time or another, either during the course of the disease or shortly before death. Secondary anemia was usually an important feature. The spleen and the liver were noticeably enlarged in many of the patients.

The symptoms referable to the oral cavity were chiefly cough, sore throat with swelling, hoarseness, pain on swallowing and aphonia. Nasal symptoms included a mucopurulent rhinitis in one case and difficulty in breathing through the nares in most cases with nasal lesions. Exudate was the chief sign of ear involvement with the addition of impaired hearing and pain. Since most of the cases had lesions in other organs as well, there were various associated symptoms depending on the organs involved of general weakness, chest pain, vomiting, shortness of breath, diarrhea associated with abdominal pain, profuse sweats, malaise, pleurisy and signs of pneumonia. The lesions involved one or more structures of the oral cavity in each case. When combined, however, it was evident that practically all the structures in the mouth or throat had been affected. Grossly, the lesions of the naso-oral cavity were nodular, polypoid, ulcerous, necrotic, verrucous, edematous, hyperemic or granulomatous. In many instances a grayish or pinkish-white exudate covered the involved structure. The nodules appeared tubercle-like. In autopsied cases, involvement of the superficial lymph nodes was an almost constant

finding. Lesions of the spleen and liver were also frequent findings. The lungs likewise were involved in most autopsied cases. Gastrointestinal lesions were noted in at least eight cases with involvement of one or more structures of the tract. This is exclusive of the lesions of the tongue and of the oral mucosa. Lesions of the skin were seen in at least six cases. The bone marrow was involved in four cases. The adrenals, kidneys, brain, heart muscle, prostate and pleura were involved in one or more isolated instances.

Clinically, the lesions have suggested tuberculosis in several of the cases and blood dyscrasias in others. Malignancy or carcinoma has been a prominent clinical diagnosis in several cases with lesions of the oral cavity. Leishmaniasis has been suggested in at least two cases and blastomycosis in one. Other diagnoses were syphilis, sepsis, bronchopneumonia, aleukemic leukemia, malignant lymphoma, Hodgkin's disease, Addison's syndrome, noma, otitis media for the ear cases, and nasopharyngitis and laryngitis.

In 13 of the 22 cases the diagnosis was made by observing the organism in tissue or blood smears and by isolating the fungus in culture either from the blood stream or from bits of tissue taken either during life or postmortem or from the sputum. In the remaining 9 cases, the diagnosis was established only by finding Histoplasma in biopsied material or in blood smears.

Treatment has been varied. Death from the disease has resulted in all cases.

DISCUSSION

The recognition of histoplasmosis or reticulo-endothelial cytomycosis as a definite clinical entity, like the discovery of other disease conditions, is one step in its ultimate control. Finding of the etiological agent of the infection is merely one part of the desired goal. We must determine also the various clinical manifestations in order to bring about early diagnosis. We must bring to light any and all characteristics of histoplasmosis which would facilitate diagnosis. This has been done rather well in the many fine publications of individual case reports, in the accumulation of data relative to one group of symptoms and to one anatomic region. The periodic publication of reviews serves as a constant reminder to clinicians that the disease is existent and is, therefore, a constant threat.

We have endeavored to describe such symptoms and manifestations of histoplasmosis as would aid the clinician in determining more easily the cause of the disease. This was perhaps best accomplished by

the preparation of the tables, listing the cases in the order of their presentation and emphasizing, in particular, the numerous characteristics, clinical and pathological, relative to the ear, nose and throat lesions. Mindful of the fact, however, that the organism of reticulo-endothelial cytomycosis does not limit its activity to one anatomic region, but rather invades systemically and spreads rapidly, we have assembled such pertinent data as would relate thereto. We realize that the symptoms of histoplasmosis are such that one of several clinical diagnoses could be suggested. However, we have attempted to describe steps in diagnosis which have been successfully employed by others and by ourselves which should dispel any doubt as to the correct diagnosis.

We have presented in concise form the symptoms relative to other parts of the body. In this respect we have classified histoplasmosis or reticulo-endothelial cytomycosis into several distinct groups. These are the cutaneous and systemic types. Under the cutaneous form of the disease we have listed the mucocutaneous, otitic and naso-oral types and under the systemic form we have described the pulmonary, gastro-intestinal, genito-urinary, bone and joint and other types. We have done this, however, with the feeling that although histoplasmosis does become generalized rapidly, there may be localization, at least temporarily, to certain parts of the body. At such times of temporary rest, the patient may seek the aid of a specialist because of symptoms referable only to that certain region.

Such data has been prepared as may be helpful to the laboratory. This included the known facts on etiology and pathology. Mycologic taxonomy is and has been a much-discussed subject. In preparing this part of the paper, all pertinent papers and data have been presented in what we hope is an impartial manner. One cannot, however, completely ignore the ever increasing number of pathogenic fungi with which one must contend in a constantly increasing list of new or unknown diseases. Such data as has been presented here has been gathered from our own observations and from those observed by others as indicated in their publications and personal communications. However varied the macroscopic picture may have been, and in the case of histoplasmosis this has not been exceptional, one certain fact stands out in all microscopic observations, namely, that the disease is essentially one involving the reticulo-endothelial system.

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TABLE I.—HISTOPLASMOSIS WITH EAR, NOSE AND THROAT INVOLVEMENT

Case No.	Author(s)	Year	Locale	Sex—Age	Race	Duration	Temperature Fahrenheit	Weight Loss	Blood Count White	Blood Count Red	Splenomegaly	Hepatomegaly	Organism
1.	Wade	1926a	Philippines	M—40	Philippino	2 yrs.	103	Emaciation	16,600 6,200	?			Seen in tissue.
2.	Dodd, Tompkins	1933b 1934	Tennessee	M—6 mos.	White	5 wks.	100	Not noted	17,700 11,640	2,070,000	+	+	Isolated from blood and tissue. Seen in blood smear and tissue.
3.	Hansmann, Schenken	1933b 1934	Iowa	M—43	White	15 yrs.	Septic	Emaciation	10,200	4,200,000	+	+	Isolated from skin nodules. Seen in tissue.
4.	Agress, Gray	1939	Missouri	M—7 mos.	White	7 wks.	98-102.4	Emaciation	6,750 5,850	4,430,000 3,140,000	+	+	Seen in tissue.
5.	Amolsch, Wax	1939	Michigan	F—8 mos.	White	4 mos.	101-103	Marked loss	5,500 1,500	3,500,000 2,000,000	+	+	Seen in blood smear and biopsy.
6.	Williams, Cromartie	1940	Tennessee	M—56	White	2 yrs.	102.4-103	50 lbs. 8 mos.	12,100	3,820,000	+	+	Seen in lymph node postmortem.
7.	Humphrey	1940	Michigan	M—18	White	19 mos.	103 Remissive	Moderate 20 lbs.	3,500 1,200	5,200,000 1,720,000	+	+	Seen in tissue.
8.	Negroni	1940	Argentina	M—40	White	?	?	?	?	?	?	?	Seen in tissue.
9.	Brown, Havens, Magath	1940	Texas	M—48	White	2 yrs.	?	108 lbs. 2 yrs.	6,600	4,960,000			Isolated from palate. Seen in tissue smears.
10.	Anderson, Michelson, Dunn	1941	Tennessee	F—8 mos.	White	4 mos.	99.4-104	Not noted	2,500 1,850	3,880,000 1,880,000	+	+	Seen in tissue.
11.	Negroni Balina, Negroni, Bosq, Herrera	1940b 1941	Argentina	M—33	White	9 yrs.	?	20 lbs.	10,200	4,300,000 3,350,000	+	+	Isolated from ulcerated tissue. Seen in tissue.
12.	Reid, Scherer, Irving Reid, Scherer, Herbut, Irving	1940b 1942	Virginia	M—38	Negro	4 mos.	100-103	50 lbs.	3,200	2,540,000	+	+	Isolated from blood. Seen in blood smears.
13.	Palmer, Amolsch, Shaffer	1942	Michigan	M—45	White	8 mos.	100-101	35 lbs.	4,000 1,650	?	+		Isolated from mouse after tissue inoculation. Seen in anal ulcer smear.

TABLE 1.—(*Continued*)

Case No.	Author(s)	Year	Locale	Sex—Age	Race	Duration	Temperature Fahrenheit	Weight Loss	Blood Count White	Blood Count Red	Splenomegaly	Hepatomegaly	Organism
14.	Simson, Barnetson	1942	Cape Province, South Africa	M—55	White	6 mos.	98.4	22 lbs. 6 mos.	2,700	4,980,000	+	+	Isolated at room temperature. Seen in ulcer smears.
15.	Dean	1942	Missouri	M—41	White	7 mos.	99.6	20 lbs.	?	?	+	+	Isolated from curettings of laryngeal tissue. Seen in tissue.
16.	Van Pernis, Benson, Holinger	1941b 1943	Illinois	M—65	White	18 mos.	98.6-100	40 lbs. 6 mos.	7,950 5,620	5,120,000 4,680,000	+	+	Isolated from laryngeal tissue and exudates. Seen in tissue.
17.	Moore, Jorstad	1943	Missouri	M—67	White	2 mos.	103.2	Emaciation	6,500 3,400 4,450	4,880,000 2,520,000 2,740,000	+	+	Seen in tissue.
18.	Sherwin	a	Missouri	M—71	White	6-9 mos.	Fever	Emaciation	5,600	4,600,000	?	?	Isolated from curettings of tongue. Seen in tissue.
19.	Parsons	a	Michigan	F—25	White	15 mos.	99.6-102.4	Not noted	2,200	1,100,000		+	Isolated from mucosal lesions.
20.	Parsons	a	Michigan	M—49	White	9 mos.	99.5-101.5	Emaciation	5,750 4,250	5,000,000	+	+	Isolated from cervical node. Seen in tissue.
21.	Burden (Chapman, Ferguson)	a	New York	M—68	White	8 mos.	100 Irregular	Continuous 10 lbs. 4 mos.	4,600 3,000 3,750	3,420,000 4,110,000	+	+	Isolated from throat and sputum.
22.	Dominguez, Golden	a	Ohio	M—53	White	6 mos.	100.4-102.2	Not noted	3,750 5,800 5,950 12,850	2,930,000 3,330,000 3,860,000		+	Seen in tissue.

a. Unreported case
b. Preliminary report

TABLE 2.—HISTOPLASMOSIS WITH EAR, NOSE AND THROAT INVOLVEMENT

Case No.	Symptoms	Other Symptoms	Location and Description of Lesions	Location of Other Lesions	Clinical Diagnosis	Treatment
1.	Cough; difficulty in breathing; sore throat.	General weakness; chest pain.	Ulcers of nasal mucosa, ala nasi; with polyps; abscess of eyelid; draining ear; ulcers of skin.	Spleen, liver, skin, lungs superficial nodes.	Nasopharyngitis; laryngitis; pulmonary tuberculosis; leprotic abscess of eyelid.	Antileprotic.
2.	Pus in middle ear.	Cough; paroxysmal vomiting; "cold."	Necrosis; ulceration; pus in middle ear.	Spleen, liver, skin, lungs, heart, brain, nodes, gastro-intestinal tract, bone marrow.	Primary blood dyscrasia.	Symptomatic.
3.	Associated symptoms.	Itching of skin; pleurisy.	Ulcers of buccal mucosa, tongue, roof of mouth; papules, nodules, ulcers of skin.	Liver, skin, lungs, lymph nodes, adrenals.	Dermatitis herpetiformis.	Roentgen rays, local and general; potassium iodide; ionized copper.
4.	Mucopurulent rhinitis; recurrent epistaxis.	Profuse night sweats; bronchopneumonic signs.	Ulcers of buccal mucosa; mucopurulent rhinitis; perforated septum; fissures about anus; ulceration of intestinal mucosa.	Spleen, liver, lungs, gastro-intestinal tract, lymph nodes, heart muscle.	Rickets; blood dyscrasia; malignancy; syphilis; sepsis; bronchopneumonia.	Antisyphilitic and symptomatic.
5.	Otitis media for 9 weeks.	Weakness; cough.	Otitis media.	Spleen; no autopsy. Organisms seen in smears.	Otitis media.	Liver extract; pentnucleotide.
6.	Sore throat with cough; swelling; difficulty in swallowing.	Shortness of breath.	Nasal mucosa reddened, swollen and covered with hemorrhagic exudate; soft palate swollen; pharynx, right tonsillar fossa, epiglottis red and edematous; deep ulcers in pharynx.	Lymph nodes.	Malignant lymphoma; fuso-spirochetal infection.	Fowler's solution; roentgen rays; neoarsphenamine, I.v.
7.	Dysphagia; hoarseness.	Pneumonia.	Ulcers of roof of mouth?	Spleen, liver, pyloris, duodenum, lungs, lymph nodes, pleura, kidneys, heart muscle, pancreas.	Pneumonia; Vincent's disease of mouth.	Roentgen rays to long bones; pentnucleotide.
8.	?	?	Vegetations and ulcerations of soft palate and naris.	?	Blastomycosis.	?
9.	Sore throat; cough; hoarseness; dysphagia.	Weakness; dizziness; diarrhea.	Granular soft and hard palate covered with hemorrhagic patches; nodular, ulcerative uvula; false cords nodular; arytenoids edematous; ulcers of tonsillar pillars, larynx, epiglottis.	Liver, bowel, intestines, lungs, lymph nodes, bronchi, rectum.	Tuberculosis; leishmaniasis.	Roentgen rays; antimony and potassium tartrate.
10.	Draining ear.	Diarrhea of 3 mos. duration; respiratory infection.	Perforation of right ear drum with escape of thick purulent material.	Spleen, liver, lungs, bone marrow, thymus, kidneys, lymph nodes, gastro-intestinal tract; Purpura of skin.	Aleukemic leukemia; drug poisoning.	Sulfanilamide; vitamins C, K; pentnucleotide.
11.	Aphonia and dysphagia for 2 mos.	Abdominal pain and diarrhea for 5 mos.	Ulceration and granulation of trachea and larynx, covered by grayish exudate. Epiglottis, glosso-epiglottis, arytenoids and cords involved.	Spleen, liver, skin, lymph nodes, pleura.	Tuberculosis.	Sulfarsenal; liver extract; tartar emetic; sodium iodide; animal charcoal.
12.	Hoarseness and cough with expectoration.	Diarrhea; weakness; profuse sweats; "chills"; bronchial breathing.	Tubercle-like lesions of eyes; edema of arytenoids; pharynx reddened, cords hyperemic and roughened.	Spleen, pancreas, liver, lungs, lymph nodes, kidneys, bone marrow, gastro-intestinal tract.	Miliary tuberculosis; bacterial endocarditis; Hodgkin's disease.	?

TABLE 2.—(*Continued*)

Case No.	Symptoms	Other Symptoms	Location and Descriptions of Lesions	Location of Other Lesions	Clinical Diagnosis	Treatment
13.	Severe hoarseness; cough; pain in throat; pain on swallowing.	Weakness.	Ulceration of upper lip; superficial ulceration of mucous membranes of mouth, tongue, palate, hypopharynx, larynx and vocal cords.	Spleen, penis, perianal region, adrenals, kidneys, lungs, small bowel, ileum, jejunum, colon, cecum.	Mucocutaneous leishmaniasis nema.	Potassium permanganate; gentian violet; 2% thymol in oil, sulfanilamide; local applications; neostam.
14.	Difficulty in swallowing; "hacky" cough.	Poor appetite.	Nodules on tongue, gums and lips which ulcerated, discharging pus.	Cervical nodes palpable; spleen and liver enlarged.	?	Antisyphilitic; local agents.
15.	Hoarseness; severe cough; dysphagia; pain deep in ears.	Stridor and dyspnea on exertion; generalized weakness.	Thick, nodular, pale epiglottis; larynx white and nodular, keratotic; involvement of false and true cords, glottis.	Skin of knee and about tracheotomy wound, bronchi.	Keratosis of larynx; carcinoma.	Fuadin; fractional irradiation.
16.	Irritation of throat; hoarseness; difficulty in swallowing; chronic cough; impaired hearing of left ear.	Increasing weakness; poor appetite; emphysema of chest; lungs hyperresonant.	Polypoid tumor of left true cord; ulceration of aryepiglottic folds and arytenoids; verrucous mass on false cords, ventricles, posterior commissures; larynx hyperemic; pyriform sinuses nodular; posterior pillars, tongue and tonsils involved; left middle ear fibrous and hyperemic; and ear drum perforated; ulcers of premolar region.	Spleen, liver, lungs, bone marrow, jejunum, lymph nodes, adrenals, prostate, chest wall, thyroid, testes.	Addison's syndrome; histoplasmosis by biopsy.	Neoarsphenamine; potassium iodide; sulfanilamide; tartar emetic; yellow bone marrow; potassium permanganate gargles.
17.	Mouth tender and "sore"; pain on drinking and eating.	Chest pains; cough.	Ulcers and granulation of roof of mouth, gingival border of lower incisors, alveolar border of upper molars and antral mucosa.	No autopsy.	Carcinoma of buccal mucosa.	Cautery excision; fuadin; suppurative therapy.
18.	Tongue painful.	Shortness of breath; orthopnea; cough.	Ulcer of left side of tongue.	No autopsy.	Carcinoma of tongue.	Radon (radium seed) implantation; symptomatic.
19.	?	Severe hemorrhages per rectum; anemia.	Ulcerated granulomatous lesion of naris, nasal mucosa; perforation of nasal septum; ulcers of oral mucosa; granulation tissue; ulcers of skin.	No autopsy.	Ulcers, cause unknown; anemia, cause unknown.	?
20.	Hoarseness and sore throat.	Malaise; loss of appetite; night sweats.	Ulcerated, granulomatous lesions of external auditory canal, tonsils, posterior surface of tongue, posterior pharynx, epiglottis, larynx.	Generalized.	?	?
21.	Hoarseness and pain on swallowing.	Weakness; loss of appetite; coma.	Ulcer of upper lip, anterior pillar of left tonsil.	Adrenals, lymph nodes.	Tuberculosis; carcinoma; trauma.	Stilbamidine; neostibosan.
22.	Sore throat; difficulty in swallowing; productive cough.	Dyspnea; generalized weakness.	Nodular, ulcerative, pale, indolent, lesions of ear, nose, pharynx, larynx, epiglottis and trachea.	Aortic valve leaflets, liver, spleen, kidneys, lungs, parotid glands.	Tuberculosis.	Blood transfusions; digitalis; sulfanilamide; anesthesia powder for throat; mapharsen.

LXIV

THE ROLE OF CILIARY ACTION IN PRODUCTION OF PULMONARY ATELECTASIS, VACUUM IN THE PARANASAL SINUSES, AND IN OTITIS MEDIA

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It was my privilege last year to give a paper at this meeting on the effects of loss of ciliary function, especially in asthma and influenza. Strange as it may seem, there are certain pathological situations in both the upper and the lower respiratory tracts which seemingly do not occur unless the cilia are functioning actively. Among these are vacuum headache, and postoperative pulmonary atelectasis, and probably retraction of the ear drum.

Once last spring one entire session of the weekly clinical pathological conference in our city was given over to the discussion of the development of postoperative pulmonary atelectasis. The literature was reviewed, and there was much excellent discussion by surgeons, internists, endoscopists, and pathologists. But there was no mention of ciliary activity in the entire discussion. It seemed to me that the ciliary mechanism must be involved, and I decided to try to determine in what manner.

The literature on the subject of atelectasis is voluminous and extends back a hundred years. Coryllos and Birnbaum[1] who have done much work on atelectasis, conclude that there is only one cause, namely, "bronchial obstruction with absorption of the air distal to the obstruction." They speak of "firmly fixed bronchial plugs" of secretion as the usual cause of obstruction. This, in fact, seems to be the belief of most modern writers.

deTakats, Fenn and Jenkinson[2] writing just last year, agree substantially that the cause is obstruction by massive secretion. "Weakened respiratory force with accumulation of mucus from insufficient movements of cilia and suppressed cough are cause enough." They cite experiments in which bronchial constriction and produc-

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tion of excess mucus were produced reflexly by chest injury and visceral manipulation.

Van Allen and Adams[63] attempted to demonstrate the mechanism of atelectasis in experiments on 51 dogs. They destroyed a ring of bronchial epithelium through a bronchoscope by application of a strong solution of silver nitrate. From these experiments they made the following conclusions; atelectasis did not develop in a normal lung during quiet respiration, but was favored by strained respiration and cough; a valvular obstruction produced it faster than complete obstruction; the pent-up air was probably absorbed by the blood. Their conclusion concerning the action of deep respiration is at variance with clinical experience which seems to indicate that deep respiration and cough prevent atelectasis. They made another observation which seems odd. Some of their dogs developed a stricture with complete closure of the treated bronchus. The lung tissue behind these closed strictures did not become atelectatic, but floated when placed in water.

Lee, Tucker, and Clerf[64] produced atelectasis in dogs by instilling into the bronchi some secretion which they had aspirated from the bronchi of a patient suffering from atelectasis.

After reading a number of these articles, one is left with several mental conflicts. Why should deep breathing prevent atelectasis in patients and produce it in dogs? If obstruction is the cause of atelectasis, why was there no atelectasis in the dogs in which the bronchi were completely closed by scar? Why do asthma patients who die of suffocation because their bronchi are so completely filled with heavy mucus not develop atelectasis? If obstruction in atelectasis is caused by reduced ciliary activity, why did the dog of Lee, Tucker and Clerf develop atelectasis? Presumably, that dog's ciliary mechanism was normal. Ciliated epithelium readily carries away large loads of tenacious mucus without any difficulty; in fact, heavy tenacious mucus seems to be carried better than any other type.[65] Why wasn't it removed from this dog? What "fixes" these mucinous "plugs" so firmly in the bronchi? How can they become "fixed" when the entire bronchial lining, so to speak, is moving upwards? One might as well speak of an object on a moving conveyor belt or escalator as being fixed. These mucus "plugs" do not appear at necropsy to be "fixed." They simply look like a quantity of secretion lying upon the epithelium. They cannot be fixed upon ciliated epithelium—yet, there they are.

Asher, the Swiss physiologist, once said in a lecture, "When two observers bring in seemingly contradictory reports, there are several

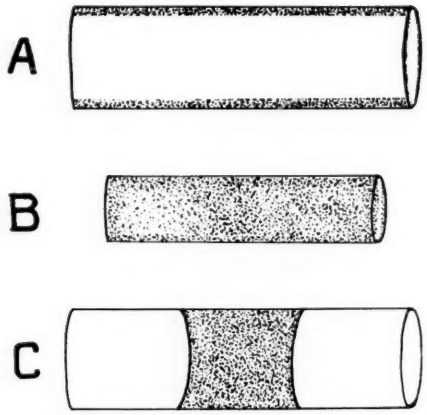

Fig. 1.—Diagrammatic representation of how mucus might span a bronchus because of changes in the length and diameter of the bronchus during respiration. Cylinders A and C measure 3 cm. in diameter, and 10 cm. in length, and contain a volume of about 71 cc. Cylinder B is one-fifth shorter, and one-third narrower, and contains only 25 cc. If cylinder A, containing a lining of mucus as indicated by the strippling, should be reduced in size to that of B, and then re-expanded to its original size C, the mucus would fill B and take a shape and position approximately as shown by the strippling in C. Something similar to this, undoubtedly, takes place in the bronchi when an excessive amount of mucus is present.

possibilities to consider. The first one may be right, and the second one wrong; or, the first one may be wrong, and the second right; or both may be wrong; or both may be right."

May we review briefly some rudimentary facts of physiology which seem to bear upon this subject? When we increase the size of the thoracic cavity by the inspiratory effort, a region of reduced air pressure is produced. Since this region is open to the out-of-doors, atmospheric pressure forces enough air into the chest to again bring the pressure up to that of the atmosphere. The air flows down through the trachea, bronchi, and bronchioles until it reaches the dead ends in the alveoli. These it picks up and carries along into the areas of reduced pressure, causing them to distend at the same time. The trachea and bronchi increase in diameter and length, and the lungs slide down the parietal pleura toward the abdomen. Expiration is accomplished by increasing the pressure within the thorax. Several factors enter into this procedure, such as the elasticity of the lungs, the weight of the relaxed chest wall, release of the abdominal organs by the diaphragm, and, when necessary, voluntary muscular contrac-

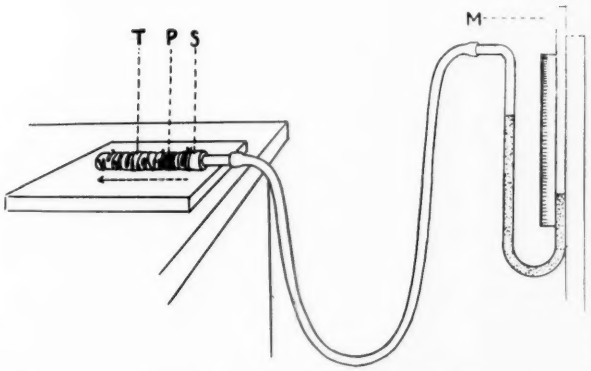

Fig. 2.—Arrangement of section of excised trachea (T) from a freshly killed hen and the water manometer (M), in the experiments demonstrating that a negative pressure is produced by ciliary action. The lower end of the trachea was stoppered and connected with a manometer while the upper, or laryngeal end, remained open. A mass of mucus (P), sufficently large to occlude the lumen, was first introduced into the lower end of the trachea, and as soon as ciliary action had started it on its journey toward the other end, the stopper (S) on the manometer tube was introduced and secured. The manometer indicated a reduction in pressure almost immediately.

A control experiment was done in which the position of the tracheal section was reversed. The stopper and manometer tube were placed in the upper or laryngeal end and the mucus again introduced into the lower end. This time a positive pressure developed promptly (Fig. 7).

tion. The contained air flows out toward a lower pressure. The lungs rise and contract, and the air passages shorten and become narrower. The movements of the lungs and the air tubes are purely passive. The volume of the lung at expiration may be readily doubled or trebled by deep inspiration. The diameter of the bronchi is said to vary as much as a third.[6] Consider for a moment what the reduction in diameter of a cylinder by one-third means in terms of volume. A cylinder measuring 10 cm. in length and 3 cm. in diameter contains about 71 cc. If it is reduced in length by one-fifth and in diameter by one-third, the volume is reduced to about 25 cc., or, by approximately two-thirds. (Fig. 1.)

The normal respiratory tract is lined with a thin film of mucus throughout its entire extent. This entire lining film is removed by ciliary action perhaps one to three times each hour, and as often replaced by the mucus glands. The total volume of mucus normally present is extremely small since the film is vanishingly thin. It has been necessary in the course of some of these experiments to obtain

small quantities of respiratory mucus. It required five decapitated hens to produce about .75 cc. The entire respiratory tracts of 12 freshly killed pigs, when hung up for about an hour, furnished at the larynx a total of between 1 and 2 cc. In the same manner it was possible to obtain about 1 cc. from the respiratory tracts of six cows.

There are some physical characteristics of this respiratory mucus which should be mentioned. It tends to span across spaces—forming bubbles, diaphragms, and threads. It has a certain tensile quality and can be dragged for a considerable distance. The cilia transport it readily and can seemingly carry a hundred times the normal load without difficulty.

A possible explanation of the development of atelectasis occurred to me, which, if true, would resolve the apparent conflicts that we have mentioned. Consequently, I spent a few days in a laboratory* in order to test this possibility. After some fruitless experiments with commercial bovine mucus, we finally found something that seemed to be significant.

EXPERIMENT

A short section of trachea, taken from a freshly killed hen, was pinned horizontally to a small board, and a mass of mucus that had been collected from the respiratory tracts of several hens was introduced into the lower end. It was sufficient in size to completely occlude the lumen. It moved by ciliary action from the lower to the upper end in a few minutes. The mucus was then recovered and again introduced into the lower end. As soon as it began to move, the trachea behind it was stoppered and connected with a small water manometer as shown in Fig. 2. Almost before the stopper could be secured, a negative pressure began to develop (Fig. 3). It reached minus 34 mm. of water in about 18 minutes.

This experiment was repeated several times with the same result each time. A negative pressure developed behind the moving mass of mucus as the latter advanced. The further the mucus advanced, the greater the negative pressure, and the greater the negative pressure, the slower the progress of the mass. Finally it would come to a complete stop. The greatest negative pressure recorded was about 35 mm. of water.

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*These experiments were done at the University of Wisconsin, in the Department of Pathology, where Acting Dean Walter J. Meek has very kindly made laboratory facilities with assistance available to me.

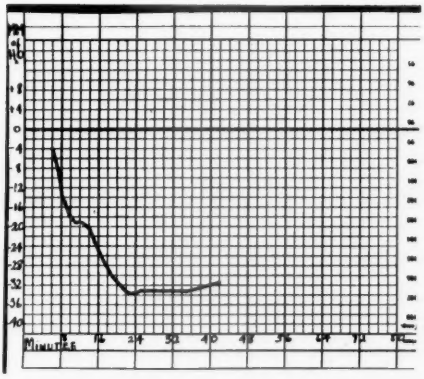


Fig. 3.—Curve showing the fall in pressure in the closed space behind a mass of moving mucus in the section of hen's trachea illustrated in Fig. 2. Ciliary action moved the mucus against atmospheric pressure, while the pressure in the space behind the mucus fell. The figures on the ordinate indicate pressure in mm. of water, while those on the abscissa indicate time in minutes. The pressure fell 34 mm. of water in 18 minutes.

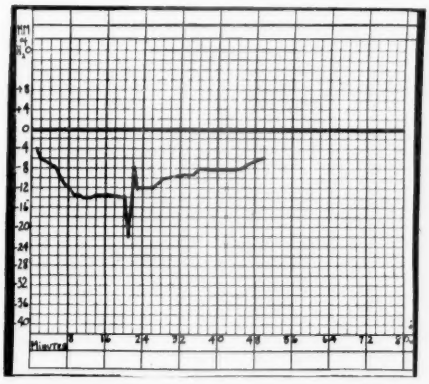
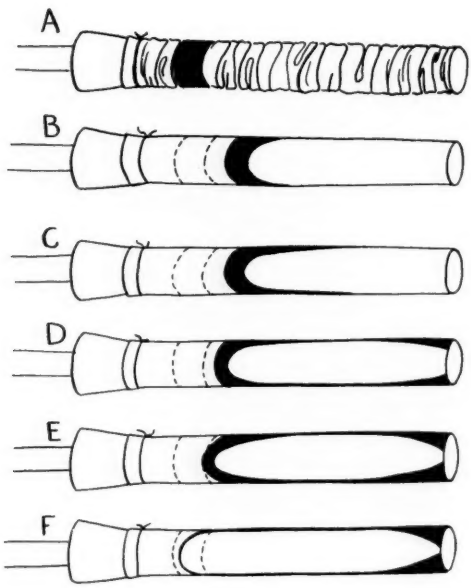


Fig. 4.—Curve showing the fall in a hen's trachea behind a mass of mucus moved by ciliary action. After 22 minutes the pressure began to rise again, and after 50 minutes had returned practically to atmospheric pressure. Fig. 5 indicates the changes in the mass of mucus which caused the pressure to rise again. The sudden, marked changes in pressure, indicated by the two sharp points, occurred when the position of the trachea was changed from horizontal to vertical. At 21 minutes the trachea was held vertically with the laryngeal end down and with the cilia working in the direction of gravity. The pressure was noted and found to have fallen 8 mm. more. At 22 minutes the trachea was held with the laryngeal end up and with the cilia working against gravity. The pressure rose 5 to 6 mm.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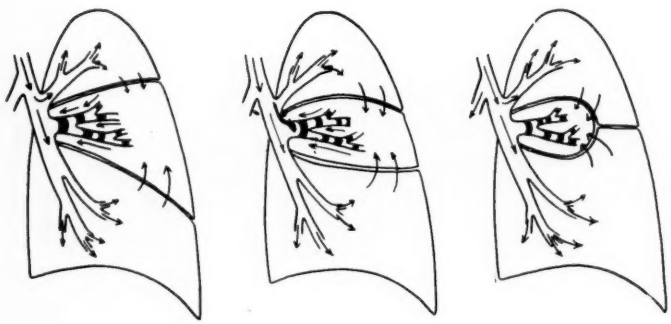

Fig. 5.—A diagrammatic representation of the changes in the shape and position of the mucus mass during the pressure change shown in Fig. 4. A shows the position when the stopper was introduced. In B it had advanced to the "stalling" point. In C the margins were advancing by ciliary action, while the main mass remained stationary, held by atmospheric pressure. D, E, and F show the progressive advance of the mucus in thin films to the cut end of the trachea where it collected in a ring. Meanwhile, the occluding diaphragm grew progressively thinner and weaker as its volume was reduced, and sagged back toward the starting position, thus causing the pressure behind it to rise again.

The dotted lines in each sketch represent the position when the stopper was introduced.

Fig. 6.—Diagram representing the various steps in the production of postoperative pulmonary atelectasis. The middle lobe is the affected one. (1) An excess of secretion is formed in the lobe. (2) A series of occluding masses, or pistons of mucus, form across the lumen. A combination of circumstances enter into their formation, such as: force of inspired air and changes in the diameter of the air passages. (3) The "pistons" move up the cylindrical air passages by ciliary action, each carrying a quantity of air. (4) As soon as the air pressure within the lobe begins to fall, the lobe shrinks by its own elasticity, and by pressure, from surrounding lobes. (5) The surrounding lobes carried by the force of inspired air move into the space relinquished by the affected one. The changes in position of the lobes, as well as their shrinkage and distension, are facilitated by the sliding motion of the lungs during respiration. (6) The advancing "pistons" of mucus rupture serially as they reach tubes of greater diameter, and meet more forceful changes of air pressure. They then release the air bubbles which they have carried and continue on their course as mural films or masses. (7) Production of considerable negative pressure in the affected lobe so great that (8) the mucus masses then present in the air passages come to a standstill against atmospheric pressure. These masses form the so-called "firmly fixed mucus plugs" referred to in the literature.

This simple experiment seems to be the key to the development of atelectasis. It is essentially a piston-cylinder action. The mucus mass, motivated by cilia, acted as a piston moving within the cylindrical piece of trachea. It formed an airtight seal and moved along until it was stopped by air pressure. It came to a standstill but was not in any other sense fixed. The cilia can move large masses of mucus with no difficulty, but they cannot lift 15 pounds of atmospheric pressure with a piston of slippery mucus. When the pressure in front of the advancing mucus piston, minus the pressure behind it, became equal to the effective force which the cilia were able to apply, then the "piston" of mucus became "stalled."

One experiment was continued for 50 minutes (Fig. 4). The negative pressure in the manometer was maintained at maximum for eight or ten minutes and then began to decrease. It finally returned again to -6 mm. from a maximum of -14 mm. Meanwhile, the mucus began to appear at the distal end of the trachea where it formed a thick ring. We removed the stopper, supposing that all of the mucus had already been transported and that the pressure of -6 mm., which still remained, must be an effect of capillarity. The water in the manometer promptly equalized. When the trachea was inspected, it was found that a very thin transparent diaphragm of mucus was still intact. This had apparently maintained the small pressure of -6 mm.

The cilia obviously had not stopped working when the mucinous piston came to a standstill. They continued to exert traction with the result that mucus was dragged away at the periphery and carried progressively toward the distal end of the trachea in a thin film (Fig. 5). The volume of the piston was reduced in this manner, thereby also reducing its thickness and strength. As it became thinner, it could no longer maintain the maximum pressure, and sagged backward in the middle, thus reducing the negative pressure. This continued progressively until all of the mucus had collected in a thick ring at the distal cut end of the trachea, and the negative pressure had practically disappeared.

It now seems possible to reconstruct the steps in the production of atelectasis in a patient who has undergone surgery and whose respiratory tract is normal* (Fig. 6). First, an abnormally large quantity of mucinous secretion is produced. This may be due to the anesthetic, a reflex stimulation, or a combination of these and other causes. Second, the secretion occludes the lumen of the air passages by span-

*The principles here outlined doubtless apply also in other forms of atelectasis.

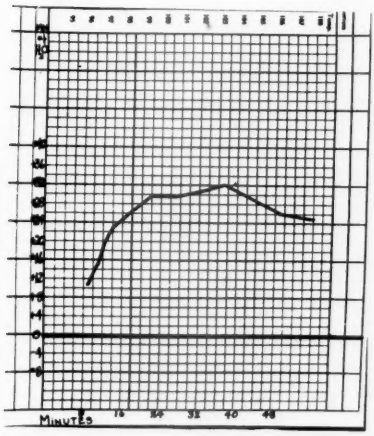

Fig. 7.—Curve showing positive pressure produced in a section of excised trachea from a freshly killed hen, when the trachea was reversed in position. An occluding mass of mucus was introduced into the lower end, and the upper, or laryngeal end, stoppered and connected with the manometer. This shows that the negative pressure found in the experiments illustrated in Fig. 2 and Fig. 3 was not due to absorption of air by the tissues.

ning across it. The following circumstances combine to cause this occlusion: force of the inspiratory flow of air, changes in diameter and length of the bronchus, the bellows-like action of the involved lobe, and the viscosity and volume of secretion. Third, the occluding mucinous mass advances up the bronchus, causing a slightly reduced pressure in the lobe. Fourth, the elastic tissue in the lobe reduces the size of the lobe as the pressure falls. Fifth, the alveoli of neighboring lobes are carried forward by inspiratory air into the space which is relinquished by the affected lobe. The sliding movements of the lungs during respiration facilitates the shrinkage of the affected lobe and the enlargement of the neighboring lobes.

These steps would be repeated many times. One mucinous piston advancing up the bronchus would not produce collapse. There would have to be a succession of them, each carrying along a volume of air somewhat on the principle of a mercury vacuum pump. Each one would eventually reach a point where the increased diameter of the air passages and the increased force of the impact of inflowing

air would rupture the diaphragm across the lumen and liberate the bubble of air behind it. The mucus would continue its journey as a mural mass or film. The pistons would continue to advance and be carried away as long as any considerable amount of air remained in the lobe. They would not come to a standstill until the pressure within the lobe had fallen to such an extent that the effective power of the cilia had been overcome. This would not occur until the air in the lobe was exhausted and the lobe had collapsed.

The seemingly conflicting observations can now be resolved. All of the observers were correct in their observations. The experimental atelectasis of VanAllen and Adams is not comparable to postoperative atelectasis because they destroyed the continuity of the ciliary mechanism, thus materially altering the conditions of the experiment. The same can be said concerning the dogs in which the bronchus became completely occluded by scar. The masses of mucus which were supposedly "firmly fixed" in the bronchi are not fixed at all. They simply have been stopped by a column of air against which the cilia cannot advance them. Given time the cilia may drag the secretion around and past this obstruction.

It has been assumed that the air entrapped behind the mucus plug is absorbed. That is, of course, a possibility, but absorption probably plays a minor role. The air is probably largely removed by this piston-cylinder action before the mucus pistons come to a standstill.

EXPERIMENT

There remained a conceivable possibility that the air in the excised trachea used in the above experiment might have been absorbed by the tracheal tissue, thus producing a reduced pressure. To determine this another experiment was done reversing the direction of the section of the trachea; that is, the upper or laryngeal end was stoppered and connected with a manometer. When the mucus was introduced at the lower end and carried upward by ciliary action, a positive instead of a negative pressure promptly developed (Fig. 7). This pressure reached -32 mm. of water and was maintained near that level for over half an hour. It did not go down, apparently because the mucus was carried against the stopper and also against the end of the manometer tube and held there by ciliary action. This experiment shows that the negative pressure developed in the experiment was not due to absorption. No one would seriously argue that the air was absorbed behind the mass of mucus and excreted again in front of it.

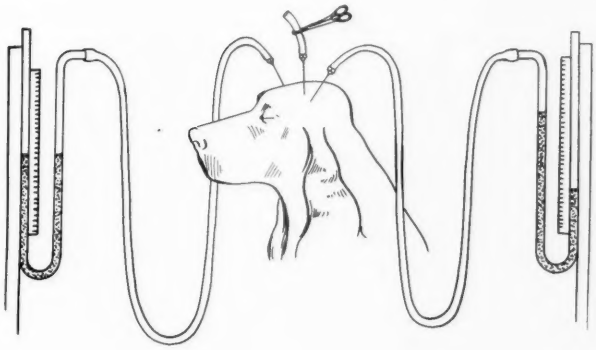

Fig. 8.—Arrangements of needles and manometers in the experiments on the frontal sinus of the dog. Mucus was injected into the left frontal sinus. A negative pressure developed as the mucus was removed by ciliary action. The right sinus served as a control and showed no change of pressure.

The question arises as to whether the ciliary mechanism can maintain the large negative pressures that are found clinically in cases of massive collapse of the lung (up to 600 mm. of water. Davies[7]). No direct observations as to that have as yet been made. But if a half cubic centimeter of mucus in a short section of excised hen's trachea and covering only a few square millimeters of epithelium can sustain a pressure of 35 mm. of water, it is not at all unlikely that an ounce or two of secretion distributed through an entire bronchial tree might sustain a pressure ten or twenty times as great. If this is not true, then it is difficult to imagine what power does hold the mucus suspended thus between atmospheric pressure and a pressure 600 mm. lower. It is hardly likely that the viscosity of the secretion could hold it, because this type of secretion can be put through a 16 or 18 gauge hypodermic needle without any difficulty.

The production of vacuum by ciliary action has applications in other fields which are of more immediate interest to most of us, namely, in the sinuses and in the middle ear.

The occurrence of headaches due to reduced pressure in the sinuses has been accepted by rhinologists for many years. Yet there has been no good evidence to support the theory, and more recently

there has been a tendency to discredit it for that reason. Proetz[8] gives Sluder credit for first popularizing the theory, but states that it was based only on Sluder's personal belief. He discusses the physics of likely gaseous exchange in a closed sinus and concludes that on this basis a slight positive pressure, but no vacuum, might develop. He mentions as a possibility that a vacuum might develop when a swollen mucus membrane within a sinus becomes depleted through its vascular channels in the presence of a blocked sinus.

There can be no doubt that a certain peculiar type of headache develops in sinusitis which may often be relieved by shrinkage of the mucosa near the ostium. It occurs after the purulent stage when the secretion is becoming heavy and mucinous. To the patient, it is an exasperating and demoralizing pain that extends into his teeth and behind the eye. Suddenly he feels, and may even hear, the leakage of air through a narrow chink somewhere, and the pain is miraculously gone. A few moments later he may spit out a large mass of viscid mucus.

The finding of the piston-cylinder action in the trachea of the hen suggested the possibility that a similar mechanism might produce negative pressure in the sinuses. With the help of Dr. H. E. Essex, of the Mayo Clinic,* we did a few successful experiments that seem to be quite conclusive.[9]

EXPERIMENT

A dog was anesthetized with ether by the open drop method. Considerable secretion gathered in the trachea from whence it was collected. This mucus was used to inject directly into the frontal sinuses of another dog.

Technic—The dog was anesthetized with ether and placed in the prone position. Two small holes were made through the roof of the left frontal sinus and one through the roof of the right by means of a punch. The holes were of such size that a Gauge 18 hypodermic needle fitted tightly in them. One needle was placed in each of the three holes. The needle in the right frontal was connected to a small water manometer and one of the needles in the left was connected to another water manometer. The right sinus served as control (Fig. 8).

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*The officers of the Mayo Foundation and Dr. Frank Mann have very kindly permitted me to use the laboratories at the Institute of Experimental Medicine and have furnished materials gratis.

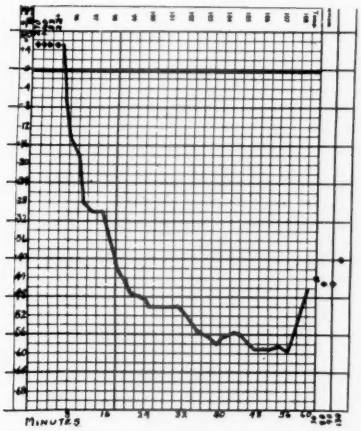

Fig. 9.—Curve showing the negative pressures obtained in the left frontal sinus of dogs after the injection of a few cubic centimeters of mucus.

A quantity of mucus (3-7 cc.) was injected into the left frontal through the second needle and the needle promptly closed off. A negative pressure, as indicated on the manometer, began to develop in the left sinus after a few minutes. The maximum recorded was -66 mm. of water (Fig. 9). There was no pressure change noted in the control sinus in any experiment.

The experiment was repeated three times. The duration of the first experiment was one hour; of the second, two hours; and the third, four hours and a half. The first failed to show change of pressure. The sinus was opened at the end of the experiment and was found to contain a very large ostium which had apparently not become occluded. The other two experiments were successful and gave similar results. Negative pressure began to show in one after five minutes, and in the other after seven minutes. Both showed an initial positive pressure, one of 15 mm. of water, and the other 270 mm. The maximum negative pressure was reached in about 25 minutes in both. The negative pressure was maintained at or near maximum for 20 minutes in one, and 34 minutes in the other, after which the pressure began to recede. Recession of negative pressure was slow and incomplete in both, according to the manometer read-

ings. In one, it receded 13 mm. (i. e., the pressure in the sinus rose 13 mm.) in 1¼ hours, and in the other it receded 23 mm. in 3½ hours.

The sinus used in the longer experiment was opened at the end of 4½ hours. It was practically empty. The end of the needle connected with the manometer was found to be plugged, and the reading in the manometer remained unchanged even after the sinus had been opened. When the needle was removed from the tubing, the water surfaces in the manometer promptly leveled.

The findings in the sinus experiments were somewhat different from those in the experiments on the trachea. There was an initial positive pressure, the fall in pressure was greater, and the return to a normal pressure reading failed to occur. The initial positive pressure was doubtless due to the fact that the ostium became covered with mucus and occluded before the entire amount had been injected. The remainder had to be forced in under pressure. The greater fall in pressure was doubtless due to a combination of circumstances, such as the larger amounts of mucus used, the difference in the shape of the cavities, and the fact that the experiments were done on the intact living animal, whereas tissue had been used in the experiments on the trachea.

The failure of the pressure to return to normal was merely apparent. As soon as the pressure began to rise, secretion entered the manometer needle and blocked it. The reason for this is the fact that the ciliary flow from some parts of a dog's frontal sinus to the ostium are routed across the roof, and a needle protruding through the roof is almost certain to be covered with secretion if any considerable amount is present. This would not affect the manometer reading materially as long as the pressure in the sinus was falling and air was passing through the needle into the sinus. However, as soon as the pressure in the sinus would rise above that in the manometer, then air would pass through the needle into the manometer and would carry secretion with it.

Clinically, vacuum in an infected maxillary sinus would apparently develop about as follows: First, the air contained in the sinus at the beginning of the attack would pass out through the ostium, as the cavity filled with initial watery secretion, and remain devoid of air until the attack was nearly over. Second, the various types of secretion (watery, purulent, and mucinous) would pass through the ostium during the course of the attack by a combination of forces, such as gravity, ciliary action, and pressure from continu-

ous production of secretion. Third, the production of secretion eventually would drop below the capacity of the cilia to remove it. This would be during the late stages when the secretion is mucinous. Fourth, the traction exerted upon the contained mucus by the cilia in the nose, in the ostium and in the sinus would cause a fall in pressure that would be abolished only when air could force its way past the secretion at the ostium and into the sinus. Fifth, despite the negative pressure in the sinus, secretion would continue to leave the sinus as the cilia remove thin films from the sides of the contained mass. Sixth, eventually the portion of the mucinous mass remaining within the sinus would be small enough to permit air to pass by through the ostium.

Several attempts have been made to produce vacuum in the middle ear by injecting mucus into the hypotympanum and the first part of the eustachian tube. To date they have not been successful. The ears of pigs and cows have been found to be unsuitable, and in my only attempt at necropsy the body was too cold. The cilia had ceased to act.

Nevertheless, I feel sure that at least under certain circumstances the action of the cilia in moving masses of mucus down the eustachian tube produce a negative pressure. We know from the retraction of the ear drum that negative pressure frequently occurs in the middle ear.

It is, of course, quite possible in all of these conditions that absorption of air by the bloodstream may play a role.

The treatment of atelectasis seems almost self-evident. Prophylaxis must seek to avoid the formation of occluding masses of mucus. All possible measures should be taken to avoid the production of excess secretion. If abnormal quantities of mucus do form, then deep respiration and frequent change of position would tend to prevent the formation of occluding masses. When atelectasis is already present, measures must be taken to replace the air in the collapsed lobe. Deep breathing may force air past or through the occluding masses. If not, then either aspiration of the mucus or inflation would be indicated.

SUMMARY

The steps in the development of postoperative pulmonary atelectasis are about as follows: (1) An excess of secretion is formed within the affected lobe. (2) A succession of occluding masses, or pistons, of mucus form across the lumina of the air passages. (3)

These "pistons" move up the cylindrical air passages by ciliary action, each carrying a quantity of air. (4) As soon as the pressure within the lobe begins to fall, it shrinks by its own elasticity and from pressure by adjacent lobes. (5) The adjacent lobes carried by the force of inspired air move into the space relinquished by the affected one. (6) The advancing pistons rupture serially as they reach tubes of greater diameter and meet more forceful changes of air pressure. Each then releases the bubble of air which it carried and continues on its course as a mural mass of film. (7) A negative pressure of considerable proportion is produced within the lobe when the supply of air is exhausted. (8) The masses of secretion then present in the air passages come to a standstill when the cilia can no longer advance them against atmospheric pressure. (9) The cilia continue to remove secretion from these "stalled" masses in thin films and might eventually remove them entirely if they were not replaced by continued secretion.

Negative pressure can be produced within a normal sinus by the introduction of a quantity of mucus which replaces a portion of the contained air. When sufficient mucus has reached the ostium by ciliary action to completely fill it so that incoming air cannot pass by, negative pressure develops in the sinus. The pressure falls as the mucus mass is progressively dragged and pushed through the ostium. When the effective power of the cilia is equalled by the difference between atmospheric pressure and the pressure within the sinus, the mass ceases to advance and the pressure ceases to fall. The cilia continue to act and remove the mucus in thin films. When sufficient mucus has been removed, atmospheric pressure forces air through the ostium into the sinus again.

Negative pressure almost certainly develops clinically in sinuses when they are more or less filled with mucus and when their cilia are active.

The negative pressure, which is known to occur within the middle ear, is probably due to the force of ciliary action moving mucus down the eustachian tube.

This work was aided by a financial grant from my associate, Dr. D. L. Tilderquist.

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LXV

INJURIES OF THE CERVICAL THORACIC DUCT

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Injury to the cervical portion of the thoracic duct is unusual enough and many times brings on such serious clinical symptoms, because of the marked metabolic upset resulting from the loss of chyle, that a discussion of the subject with case reports should be made when the occasion arises. The importance of this condition is emphasized by all types of war injuries of this region.

Snedecor[1] reported a case of traumatic injury of the duct and was able to collect only eight other cases.

The thoracic duct begins at the cisterna chyli, between the aorta and the right crus of the diaphragm, at the level of the first and second lumbar vertebrae. It passes upward through the aortic opening of the diaphragm, enters the posterior mediastinum, and ascends in front of the vertebral column to the level of the fifth thoracic vertebra. There it crosses to the left of the median plane and ascends through the superior mediastinum to the root of the neck, where it turns laterally between the vertebral and common carotid arteries. It descends across the subclavian artery to end at the medial border of the left scalenus anterior by joining the left innominate vein in the angle of the junction of the internal jugular and the left subclavian veins.

At the root of the neck, opposite the lowest cervical vertebrae, it arches laterally above the apex of the pleural sac and then downward and forward across the first part of the left subclavian artery. It passes in front of the vertebral artery and vein, the roots of the inferior thyroid, transverse cervical, and suprascapular arteries, the medial border of the scalenus anterior and the left phrenic nerve, and behind the left carotid sheath and its contents.

From the Department of Otolaryngology, University of Tennessee School of Medicine.

According to Stuart[2], the highest point of the terminal arch may be low, the convexity being flat, or it may extend unusually high, sometimes to the level of the fifth cervical vertebra. Dietrich[3] has found the arch 5.5 cm. above the top of the sternum, touching the thyroid gland.

The duct frequently terminates by breaking up into several branches in a delta-like manner in the neck with each of these branches communicating with a large vein. This type of termination is described by Parsons and Sargent[4] in 18 of 40 cases. Lilienthal[5] mentions the presence of a semilunar valve that guards the opening into the vein. The duct receives lymph from the left side of the neck, the head, the heart, and the left arm shortly before its termination, according to DeForest[6].

In the thoracic portion of the duct there exist numerous variations that assume considerable significance in the advent of injury of the duct in the neck. Davis[7], on dissecting 22 cadavers, found numerous variations formed by anastomoses of the main duct on the left and the main duct on the right. Butler[8] describes a case in which the duct divided at the level of the third thoracic vertebra. One branch pursued a normal course through the neck; the lower branch, however, passed up and out in close relation with the left subclavian artery. He does not consider this type of division rare. He also describes a case in which the duct broke up into a plexus in front of the sixth, seventh, and eighth thoracic vertebrae, with relatively large communicating branches to the veins of the left and right sides of the neck. Parsons and Sargent[4] also mention the presence of a communication between the right lymphatic duct and the thoracic duct in occasional instances. Scott[9] notes "many" openings into the azygos veins and also a free meshing with the mediastinal glands and the intercostal veins.

Sabin[10] states that in the embryo two ducts begin at the cisterna chyli; both pass through the thorax, and the right crosses over to join the left at the level of the fourth thoracic vertebra to form a single trunk. The two ducts in the embryo are connected by numerous cross anastomoses. Thus potentially there are two complete thoracic ducts. Drinker[11] states that, although intercommunication between the thoracic duct and the right lymph duct does not actively function in more than one out of five human cases, it will open if the thoracic duct is closed in the neck, thereby allowing the right lymphatic duct to assume the function of the thoracic duct. Lilienthal[5] also states that anastomosis between the right and the thor-

acic ducts becomes established eventually when the thoracic duct is obstructed.

Parsons and Sargent[4], Lee[12], and Stuart[2] mention occasional communication between the thoracic duct and the vena azygos. Lee[12] observed the formation of a collateral lymph circulation to the right duct when the thoracic duct was ligated in necks of cats. Matas[13] states that the lymph ducts in the thorax and neck empty into neighboring veins along the subclavian tract through variable but numerous collaterals.

The thoracic duct is the channel through which lymph, bearing fat absorbed from the lacteals of the small intestine, flows from the receptaculum chyli into the vascular system. Any wound of the duct of sufficient size to allow lymph to escape will cause interference with the bodily nutrition, as absorbed fat will be lost, the amount depending on the size of the wound. Large amounts of fluids and the other components of lymph are also lost.

The symptom of injury to the cervical portion of the duct is a flow of milk-like fluid from the site of the injury. When the fistula is complete, the volume of fluid lost is very large, as much as several pints daily. This dehydration produces excessive thirst, decreases urinary output, and the skin becomes dry. The loss of the fat results in rapid depletion of bodily fat depots, with loss of weight and marked weakness. This was found to be true in our patient even though she was on a diet high in carbohydrates and proteins.

There were no reported cases of traumatic injury to the duct in either the Civil War or in World War I; concomitant injury to the large vessels of the neck probably overshadowed any signs that would point to such injury to the duct. Due to the scarcity of reported cases of nonsurgical injury to the cervical thoracic duct, it is necessary to refer to cases in which the duct was injured during the course of operative procedures in the left cervical region in order to study methods of treatment. Wounds of the thoracic duct have been treated by numerous methods. Packing of the wound in the skin and tissues adjacent to the injured duct has been successful in the hands of Matas,[13] Fay,[14] Pearson,[15] Grant,[16] Allen and Briggs,[17] Cushing,[18] Schroeder and Plummer,[19] Lund,[20] Edington,[21] Senn,[22] and Lyne.[23] Following firm packing of the wound with gauze the flow of lymph gradually subsided; granulations appeared in the depths of the wound and gradually filled the cavity. Some used pressure dressings and others did not. The end results were not appreciably improved by such a pressure dressing.

Phelps[24] and Schwinn[25] placed a hemostat on the injured duct and left it in situ for three days. Each of these patients was cured by this treatment.

Fay[14] states that the duct has been ligated clinically and experimentally with no ill effect. Smith,[26] Schroeder and Plummer,[19] Schorborn,[27] Bucknall,[28] and Fullerton[29] have ligated the duct when it was injured during surgical procedures.

Deansley[30] implanted the end of the severed duct into the internal jugular vein after the latter had been ligated, there being simultaneous operative injury during the removal of tuberculous cervical glands. Harrison[31] implanted the injured duct into the external jugular vein in a similar accident and the patient also recovered.

Lateral suture of a laceration in the duct wall caused during operative procedures was followed by uneventful recovery in cases reported by Derge,[32] DeForest,[6] Lund,[20] Cushing,[18] Keen[33] and Allen and Briggs.[17] We believe that suture of the wound or of the laceration of the duct wall to be ideal treatment when this is practicable. However, as the vast majority of cases treated by simple packing of the wound with gauze have been successful, and as this procedure remains the simplest one available, it should probably be tried first in any case where the injured duct is not already well exposed.

Implantation into an adjacent vein is a physiological procedure worthy of recommendation in those cases of operative injuries of the duct in a sterile field that are too extensive for satisfactory lateral suture of the defect. We feel, though, that this procedure should not be undertaken in any case in which the injury is produced by an external penetrating wound of the neck or in cases in which the wound of the duct is not recognized until some time following the original operative procedure. The hazard of possibly introducing infected material into the venous system outweighs the physiologic advantages of this technic.

Ligation of the duct has given uniformly successful results in the cases in which it was employed. It is probably an additional precaution to suture the adjacent fascial or muscular tissue over the ligation for further support. This method is of particular value in those operative cases which have not responded favorably to tamponade with gauze packing and in cases resulting from external trauma, for here the possibility of infection is higher. The local use of the sulfonamides at the time of closure seems a reasonably desir-

able addition to any technic chosen for treatment of thoracic duct wounds.

It is suggested that, one hour before any operative procedure for closure or repair of the injured thoracic duct is undertaken, a fat meal be given the patient, thus insuring a distinct milk-like flow of chyle which will aid materially in the visualization of the duct. Preoperative administration of morphine is contraindicated, as this markedly decreases the flow of chyle.

REPORT OF A CASE

J. W., a colored female 30 years of age, was admitted to the John Gaston Hospital on September 3, 1942, with a history of having been shot in the neck about an hour before admission. She stated that the bullet entered the left side of the neck and did not emerge and that there had been only a slight loss of blood.

Examination revealed a penetrating wound opposite the thyroid cartilage, in the anterior border of the sternocleidomastoid muscle on the left side. The patient could talk, swallow and breathe normally. The blood pressure was 130/68, the pulse 95; respiration 24; and the temperature 99° F. An x-ray film of the neck revealed the bullet at the left of, and immediately anterior to, the body of the first dorsal vertebra, just to the left of the midline.

On September 5, 1942, under ether anesthesia, an incision was made along the anterior border of the left sternomastoid muscle, extending above and below the portal of entry of the bullet. The pathway of the bullet pierced the sternomastoid, tore the carotid sheath and the internal jugular vein, and terminated behind the prevertebral fascia at the level of the first thoracic vertebra, just to the left of the midline. The injured internal jugular vein was ligated above and below the level of the injury. As the bullet was approached, a straw-colored fluid began to well up from the depths of the wound. This persisted throughout the remainder of the operation. After the removal of the bullet the wound was dusted with sulfanilamide powder and packed with iodoform gauze; the skin was not closed. Within a few hours the dressings became saturated with a watery fluid. There was little bleeding. The iodoform pack was removed the following day. A large quantity of straw-colored fluid drained from the wound almost continuously. The wound was dressed daily for a week and every other day after that time.

The patient consumed an average diet until October 3, 1942, at which time a high protein diet was instituted. She lost weight gradually and continuously and on October 14 she weighed 89 pounds, having lost approximately five pounds per week.

During this time the only change in the character of the discharge was that the fluid became milk-like shortly after the patient began to eat following the operation. It was decided at this time that packing was certainly ineffective, and on October 15, 1942, the wound was explored under ether anesthesia and the source of origin of the lymph flow was determined. A probe was inserted into the lumen of the duct, running downward from this point. Considerable fibrosis had occurred throughout the wound, but the duct-like mass was dissected downward. A definite lumen was probed for about an inch. The duct was clamped and the flow ceased; ligation was then done with No. 1 Deknatel and the wound packed with iodoform gauze.

On October 16, 1942, the wound was repacked with iodoform gauze and found to be dry. However, on October 19, while we were attempting to remove a small part of tissue above the point of ligation, the ligature slipped off and the flow of chyle recommenced. The patient was taken to the operating room and the wound edges were infiltrated with one per cent novocain. The wound edges were then retracted and the duct identified by tracing the flow of lymph. The duct was freed and doubly ligated with No. 2 chromic catgut. The adjacent tissues were then sutured together over the duct, and sulfanilamide powder was dusted into the wound and the wound closed tightly by three layers of No. 2 chromic catgut interrupted sutures. There was no further discharge from the wound nor any swelling under the skin that would indicate leakage of the duct.

On October 16, 1942, the patient complained of hoarseness, and mirror examination of the larynx revealed an abductor paralysis of the left cord. However, in January 1943, normal motility of both vocal cords was observed and voice sounds had returned to normal by this time.

The patient ate well and gained weight rapidly, although she complained of generalized cramp-like abdominal discomfort following meals during the first two weeks after operation. This gradually subsided. These symptoms were interpreted to be due to lymph stasis and pressure in the thoracic duct which was relieved as soon as collaterals below the ligation became patent.

The patient was discharged from the hospital on November 19, 1942, at which time she weighed 105 pounds.

Comment.—During the interval between the removal of the bullet and ligation of the duct, the character and the rate of flow of lymph were studied*. It was shown that ingestion of food tripled the flow of lymph. Administration of water by mouth increased the flow somewhat, and magnesium sulphate by mouth had little or no effect on this increase. Morphine sulphate reduced the flow markedly.

That the fistula was complete was proved by feeding olive oil stained with Sudan IV. Afterwards highly stained fat was present in the flow from the fistula and none of it appeared in the blood stream. The plasma remained clear (no obvious fat being present) after the olive oil administration. After ligation of the duct, fat appeared in the plasma following olive oil administration, indicating re-establishment of the flow of thoracic duct lymph into the bloodstream. On October 3, 1942, plasma proteins were 3.5 mg. per 100 cc. On October 14, 1942, the total serum proteins were 4.6 mg. per 100 cc.

SUMMARY

1. The tenth case of traumatic injury of the cervical thoracic duct has been presented.

2. Studies of the physiology of the thoracic duct were conducted in our case.

3. The literature has been reviewed to present various phases of the treatment of the injured thoracic duct.

4. The anatomy of the thoracic duct, the signs and symptoms of injury to the duct, and methods of treatment are presented.

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*These observations were conducted under the direction and supervision of Dr L. A. Crandall, Professor of Physiology, University of Tennessee School of Medicine, and form the basis for a more complete report to appear in a separate article in the Journal of Gastroenterology.

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LXVI

HEARING—A POST-WAR PROBLEM

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Post-war America has an excellent chance of being a hard-of-hearing America because of the increased amount of acoustic trauma. This holds true not only for the average American who has gone to work in war industry, but more so for the young adult between 18 and 35 who in the past has been particularly free from the onset of auditory disturbances.

In the past hard-of-hearing patients fell, in general, into two large groups determined by the onset of hearing impairment. The first group is found among the young below eight years of age with an etiology of otitis media, lymphoid hyperplasia, exanthematous diseases and congenital malformation. The second comprises the late middle-aged with their perceptive deafness and otosclerosis.

The onset of deafness between the ages of 18 and 45, barring otosclerosis which occurs particularly in women, has been comparatively infrequent. This age group today is undergoing severe acoustic trauma and may well become our auditory cripples of tomorrow. The amount of auditory impairment with which these men come out of the war will have a great bearing on their post-war employment.

Acoustic trauma in the past has more or less been identified by the medical profession with workers in a few specific trades, such as boiler makers, riveters and blasters, who made up only a small percentage of the hard of hearing of a nation. The impairment in this industrial type of deafness was mainly in the higher frequencies, usually starting above 3000 frequency, and as time progressed spreading fanwise into the conversational ranges if the acoustic trauma persisted.

World War I had comparatively little effect on the hearing of the servicemen because of the relatively short duration of the war. The English and the French showed a much greater loss from an auditory

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standpoint. World War II presents a different picture in the increased pace of mechanical warfare. The rapid fire Garand rifle is replacing the Springfield. Tanks are larger, speedier, carrying larger cannons, thus greatly increasing the noise factor. This is an era of fast airplanes, dive bombers with increase in intensity of motor noises. Quick changes in altitudes with the resulting marked differences in barometric pressure and increased fire power of cannon particularly in rapidity of fire are factors. Protection to the ears has as yet not progressed as fast as the new engines of death and destruction.

Much has been written about the effects of the air and submarine services on the hearing acuity of their personnel. There is a temporary loss of the high tones at 4096 frequency, which over a period of time may become permanent and spread fanwise. The end result depends somewhat on the ability of the auditory apparatus to withstand trauma, on the amount of exposure, and the amount of rest in between exposures. The amount of protection given by various devices also is a factor.

The air and submarine personnel are carefully chosen with regard to their ears, noses and throats. Hearing acuity is checked for low ranges (whispered voices) and high tones in the region of 4096 (coin click). Audiometers are used frequently in checking doubtful cases on the cadet selection boards.

The ground forces are exposed to more acoustic trauma than is generally appreciated. The trauma may take the form of explosions, such as gun and cannon fire or a continuous type of noise as found in a tank. The hearing requirements are lower in these branches of service as not as much attention is paid to potential causes of trouble in the ear, nose and throat, such as patency of the eustachian tube, deviated septum. The amount of protection to the ear drums is not as great as in the air and submarine personnel. This applies particularly to the foot soldiers.

The acoustic trauma may take several forms.[1] The force of rapid fire rate in the modern gun does not allow the stapedius muscle to act as a protector, so the labryinth receives a much greater shock. The drum is frequently ruptured; such ruptures are often large and many never heal because of the extent of the perforation. The possibility of secondary otitis is always present following rupture to the drum. A thickened and scarred drum with some decrease in motility of the tympanic membrane is usually the least amount of damage done after such a perforation. There are in these cases a break in the conductive system with a resulting hearing impairment. However, the

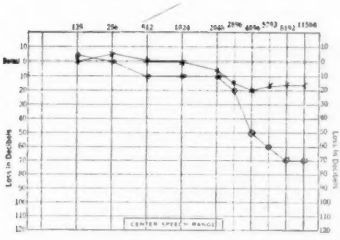

Fig. 1.

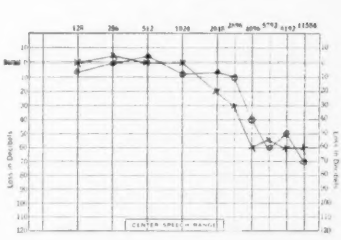

Fig. 2.

Fig. 1.—Audiogram of R. F., aged 28, a trapshooter who shot three times a week over a period of five years. The Rinne test is strongly positive. The tympanic membrane is normal; there is no history of earache.

Fig. 2.—Audiogram of L. S., aged 22, a Marine who saw action in Solomons. The Rinne test is positive, both drums are intact, there is no history of ear troubles. He was subjected to machine gun and rapid automatic fire. It is noted that, in line with Dore's[2] finding, the deafness is of a perceptive type and worse in the ear closer to the gun; both of these men being right-handed, the left ear is impaired.

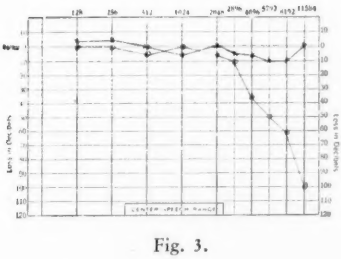

Fig. 3.

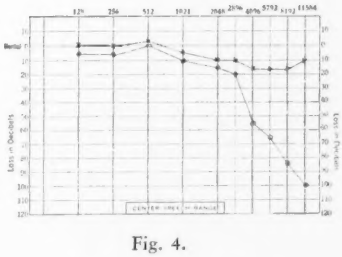

Fig. 4.

Fig. 3.—Audiogram of R. T., aged 28, a rifleman in the Marine Corps. The Rinne test is positive; the drums are negative.

Fig. 4.—Audiogram of a tank gunner, aged 24. The Rinne test is positive. There is no history of ear trouble. He has been in the Tank Corps 18 months, but seen no foreign service.

main type of damage to the hearing acuity is a perceptive type of deafness due to damage to the structures of the labyrinth. Sudden acoustic shock is translated to the parts of the basilar membrane and the organ of Corti which is nearest to the oval window. Continuous noise is more evenly distributed along the membrane and has less disruptive effect than sudden or intermittent noise. The pathological finding is atrophy of the organ of Corti in the basal coil. The organ of Corti differs in its sensitiveness to acoustic trauma both as to the individual himself and the type of noise. Thus two people with the same amount of original hearing and subjected to the same amount of acoustic trauma may have different amounts of hearing impairment. Thus the conductive deafness may largely disappear with time while the perceptive deafness remains permanent and it is therefore hard to predict by the condition of the drum how much of hearing impairment will remain.

Sensitiveness of the ear to ordinary rifle fire has long been known and the development of a "trap shooter's ear" has been found frequently.

An analysis of the examples taken from a series of audiograms shows a loss in the higher frequencies which in this length of time must be considered a permanent loss. Fig. 1 simply calls to mind the effect of ordinary gun fire over a period of time. This picture is typical of a trap shooter's ear.

Figs. 2 and 3, audiograms of riflemen armed with the Garand type of rifle, show a similar pattern to Fig. 1. Fig. 4 shows a perceptive type of deafness in a tank driver.

Fig. 5 shows a marked dip at 4096 and a progressive fading from the normal line. This man was with an anti-aircraft unit in the Pacific from Pearl Harbor. He has also been given large doses of quinine for malaria. The concensus of opinion of Navy men seems to be that the 3 mm. anti-aircraft gun, which has an explosion of higher frequency than some of the larger guns and great rapidity of fire, does more damage to the hearing noticeable to the men than any other gun in the Navy. The effect of the quinine therapy on an already injured auditory neural system may be considerable. This man states that a small amount of quinine causes an increase in the buzzing.

Fig. 6 shows the effect of conductive deafness due to perforation of the drum plus perceptive deafness. He was also an anti-aircraft gunner.

Figs. 7 and 8 are audiograms of a tank driver and a gunner. There is also a loss for high tones. There is not only the continuous

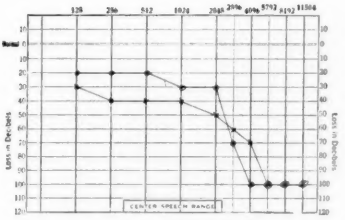

Fig. 5.

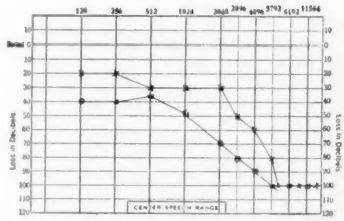

Fig. 6

Fig. 5.—Audiogram of A. L., aged 20, a Marine, anti-aircraft gunner. The Rinne test is positive. There is no history of ear trouble before January, 1942. The drums are scarred; there is decrease in motility. He had malaria and has been given large doses of quinine.

Fig. 6.—Audiogram of T. O., aged 24, a Marine, 3 mm. anti-aircraft gunner. The Rinne test is positive. There is a large perforation in both drums, no previous history of ear trouble.

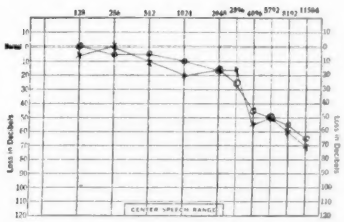

Fig. 7.

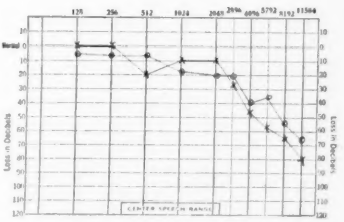

Fig. 8.

Fig. 7.—Audiogram of R. S., aged 26, a tank driver. The drums are negative. The Rinne test is positive. No previous history of ear trouble.

Fig. 8.—Audiogram of Y. C., aged 20, a tank gunner. The drums are negative. The Rinne test is positive.

noise of the tank engine in movement but also the explosion of small cannon and machine guns carried by the tank. Both wore ear plugs. These filter out about 25 decibels of noise.

These following examples were taken from servicemen between the ages of 18 and 35 years, all in the Navy, Marines and Army ground or sea forces. All had been in at least six months and all were from the reserve corps so no professional soldiers and sailors were included. Twenty-two have been overseas and all had undergone acoustic trauma of varying amounts.

	Number	Hearing impairment loss of 20 db. or more below 5000
Gun Crews	26	21
Tank Corps	12	6
Infantry	28	10
Total	66	37

The amount of hearing loss seemed proportional to the actual time they had been subjected to the traumatic noise of their branch. Every man who had been in the gun crew for eight months showed impairment. The significant fact here is that 55 per cent of the small group tested in an age group where the amount of hearing impairment is usually very small, showed impairment. It is much too early to attempt to estimate the auditory impairment brought about by the war. It is interesting however to see the trend in a small group of cases.

The hearing losses from trauma are usually found in the higher frequencies and in many cases there is but little impairment of the hearing in the conversational range. Repeated trauma over a period of time tends to cause impairment in the lower conversational range frequency. Particularly susceptible are those individuals who enlisted with a sub-normal hearing. The ability of the ear to withstand punishment varies with the individual.

Hearing impairment will be a definite post-war problem both for the employer and the employee. A thorough examination of the hearing should be done before discharge from the armed services to help the man find a job he will be able to hold and to protect the government and the future employer from subsequent medical legal action.

SUMMARY

Audiometric readings were taken on a group of individuals who have been in the ground services six months or more and in an age group where there is normally little impairment of hearing. All of the subjects were withdrawn from civil life by either selective service or voluntary enlistment and the majority plan to leave the armed services at the close of the war.

The effect of trauma to the hearing apparatus and the methods by which it takes place is discussed and typical audiograms are presented. The effect of massive doses of quinine on an already impaired perceptive system is mentioned. Post-war legal aspects are discussed.

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LXVII

CHRONIC OSTEOMYELITIS OF THE SKULL

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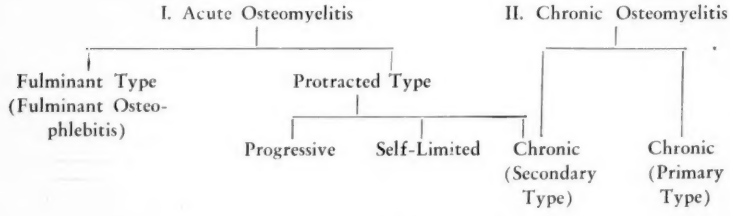
Despite the great number of excellent papers, there is still a wide diversity of opinion in respect to many phases of osteomyelitis of the skull. In a recent paper, the writer[1] submitted the following classification which has been found helpful in appraising individual cases which come under the care of the rhinologist. However, the classification cannot be considered definite.



In the quoted paper, I was chiefly dealing with the different types of acute osteomyelitis, while chronic osteomyelitis was presented in a summarized form. Inasmuch as chronic osteomyelitis seems to be less frequent than the acute type, and inasmuch as there are several problems involved in that disease, I believe that an exhaustive presentation of my experience concerning chronic osteomyelitis might be of some interest.

Chronic osteomyelitis differs from the acute form almost in every respect. Therefore, the differential diagnosis between the two types, as a rule, does not meet with great difficulty. However, among the cases of chronic osteomyelitis there seem to be two different types: one type which presents the typical features of an acute osteomyelitis at the onset of the disease and another type which does not. In order to differentiate these, we call the latter type "chronic osteomyelitis of primary type," the former "chronic osteomyelitis of secondary type."

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CHRONIC OSTEOMYELITIS OF PRIMARY TYPE

REPORT OF CASES

CASE 1.—R. G., 80 years old, white, female. For many years she suffered from urticaria after eating eggs. On June 18, 1936, after having eaten strawberries she noticed a swelling on the tip of the nose which extended over the eyelids toward the glabella. A diagnosis of Quincke's edema was made. The swelling decreased very soon, although, it did not entirely disappear at the glabella, where it turned into a tumor the size of a plum and began to fluctuate. There was little pain and no fever. On August 13, the swelling was incised, but the wound did not close and a draining fistula was established. A tentative diagnosis of malignancy or tuberculosis was made. X-ray treatment was administered.

I saw the patient on November 18, 1936. There was a fistula at the glabella, the opening of which was surrounded by necrotic granulations. Thin, nonfetid pus drained from the fistula with pulsating motions. With the probe necrotic bone was felt in the depth of the fistula. The rhinologic findings and the Wassermann reaction in the blood were negative, but there was an atheromatosis of the aorta. There was no leucocytosis in the blood. X-ray examination showed a penetrating defect at the glabella the size of a quarter. The margins of the frontal sinus, close to the defect, were indistinct. There was a small sequestrum in the inferior part of the defect. There were no signs of malignancy, lues or tuberculosis.

On November 24, the osteomyelitic area was exposed and a sequestrum, 1 cm. in diameter, was removed. The dura was covered with necrotic granulations. The boundaries of the defect of the bone were sclerotic and covered with granulations. The wound was left open. During the after-treatment a (metastatic?) abscess developed in the left forearm, the pus of which was sterile. On January 12, 1937, she was dismissed as improved.

Comment. The etiology of the osteomyelitis in the presented case is not clear, but it is probable that it followed an erysipelas which was believed to be an edema of Quincke. The osteomyelitis did not invade the frontal sinus, but in five months a sequestrum developed which included the entire thickness of the frontal squama and was removed. During the convalescence an abscess developed in the left forearm. Whether or not the abscess was of metastatic origin cannot be stated. The age of the patient is noteworthy.

CASE 2.—J. S., 9 years old, white, female. As the history of this case was published by Lewy[2] only a brief summary is given. However, the last operation, which was not reported, is described in full. In November 1937 this patient had scarlet fever. Ten days after the disappearance of the exanthema an abscess developed over the left eye and was incised. Following the incision a draining sinus developed.

On admission, August, 16, 1938, there was pus in the left middle meatus and the nasal septum was deviated to the left. There was a draining sinus over the left eye. X-ray examination revealed a cloudiness of the left ethmoid and the left maxillary sinus; the frontal sinuses were not yet developed. There was an irregularly shaped sequestrum in the frontal bone above the left eyebrow.

Three attempts were made to remove the sequestrum; all failed, as the sequestrum was firmly attached to the bone and a forcible removal of the sequestrum could not be ventured because of possible injury to the adjacent lamina cribrosa.

On December 8, 1941, there was a swelling over the left eye extending over the midline. The fistula above the mesial canthus of the left eye was still draining. X-ray examination showed the bone defect unchanged. The girl felt very well otherwise, had gained weight and there were certainly no signs of toxemia.

On January 10, 1942, under anesthesia given intratracheally, an incision was made in the midline of the forehead down to the ridge of the nose. The incision was connected with the Killian incision below the left eyebrow. The periosteum was easily stripped from the frontal bone which was white and showed many bleeding spots. Around the supra-orbital arch, the periosteum adhered very closely to the bone and was separated by sharp incision. In the roof of the orbit, extending over the mesial part of the supra-orbital arch, there was an area of granulations surrounded by thickened white bone of the frontal squama. After removal of the thickened bone two sequestra were found. In order to remove the sequestra, the bone was chiseled off to the midline and a defect the size of a quarter was created. The bone had a thickness of about 0.75 cm., consisting of spongy bone, and there was only little bleeding. When the sequestra were removed, there was a groove in the bone reaching the thickened interfrontal septum. In the anterior part of the septum there was a perforation filled with the normal mucosa of the right frontal sinus. The perforation was enlarged and the right frontal sinus was opened widely. In the mesial and inferior parts of the

groove there was an opening leading into the nose which was made at the prior operations. The floor of the groove consisted of hyperostotic bone which was removed, exposing the dura, the size of a dime. The dura was adherent to the bone, had a milk-white color, was of the consistency of a blister and after removal of the bone the escaping blood apparently was mixed with spinal fluid. These findings pointed to the existence of an arachnoidal cyst. The incision was entirely closed except in the area of the inner canthus.

After the operation the patient made an uneventful recovery. When the patient was seen for the last time, in March 1943, she was entirely well and there was no fistula in the eyebrow.

Microscopic Examination. One of the bone chips contained two compact bone layers and a diploe between them. One layer consisted of compact bone presenting the structure of agate bone, the other of lamellar bone with small marrow spaces containing slightly inflamed connective tissue. At the boundaries of these spaces were osteoblasts, occasionally an osteoclast. The diploe contained mixed marrow, most of the marrow spaces being aplastic. In a few marrow spaces osteoblasts were found.

Comment. In the presented case an osteomyelitis developed in the left part of the frontal squama following scarlet fever. On that side, there was no frontal sinus, while on the right side the frontal sinus was small. It took about nine months for the development of a sequestrum which did not change for a period of three and one-half years. The sequestrum was lying on the dura and had produced, probably by toxins passing through the dura, an arachnoidal cyst. When the sequestrum was loosened, it was removed and the patient was cured.

CASE 3.—A. M., 30 years old, white, female. This patient was first seen by Dr. L. Ostrom, Rock Island, Ill., on May 9, 1933, and gave the following history: When eight years old, she fell off a horse on her head striking the left mastoid. By the accident the occipital bone was fractured; this was proven by x-ray examination 14 years later. The area pained her for some time but there were no ear troubles of any kind. The left ear began to ache in 1932, 14 years after the injury. There was spontaneous discharge from the ear which has continued ever since.

In May 1933, she complained of pain on the left side of head, particularly about the temple, behind and above the mastoid, and constant, profuse discharge which was watery, blood-tinged at first, and later became creamy. There was a central perforation of the

left ear drum and the hearing was markedly decreased on that side. There was no pain, tenderness or edema of the mastoid. On June 12, 1933, she woke up with earache and increased discharge from the ear. Her temperature was 100° F. to 101° F., but there were no other complaints. On June 19, a simple mastoid operation was performed by Dr. Ostrom. Much necrotic bone was removed from the lateral sinus and antrum and a large cell was exenterated in the external half of the digastric groove. On June 30, the wound looked normal, but about one-half of an ounce of creamy pus welled out when the posterior portion behind the sinus was being dressed. Spicules of sequestra were found at times during dressings, but there was no pain or discomfort and the wound seemed to heal normally until July 17, when she had a temperature of from 99° F. to 101° F. and a painful area below the ligamentum nuchae. On July 28, there was a large swelling over and below the ligamentum nuchae with fluctuation. Under gas anesthesia, a large opening was made and three to four ounces of creamy pus escaped. The probe did not find any sinus into the occipital bone.

For one year the wound was dressed as necessary and occasionally sequestra were found on the dressings. On July 6, 1934, she developed generalized headache and more discharge was found from the posterior portion of the mastoid wound and from the neck. The probe passed straight back two inches and also passed deep under the mastoid tip from behind. On August 14, 1934, the scalp incision was extended back to the torcular and the bone was exposed. The probe now was passed from the posterior neck wound through a sinus in the occipital bone up and forward into the mastoid wound indicating a large extradural abscess in the posterior fossa. The fracture of the occipital bone was visualized and the bone was removed to within two inches of the torcular and down about one and a half inches. Following one blood transfusion she made a good recovery, but the wound still drained and sequestra kept appearing on the dressings. Some were as large as fish vertebrae.

She did well until the first days of February 1935, when she again began to have fever. The probe could be passed deep between the skull and the dura, backward and downward, through and out of the wound of the neck. If the drainage stopped at times, she had pain and fever. In order to hear better, she compressed the right carotid artery, but became dizzy if the pressure was too long or too hard. There was no reaction when she pressed the left side. From then on, discharge and discomfort increased, and in October 1937 she entered the Research and Educational Hospitals.

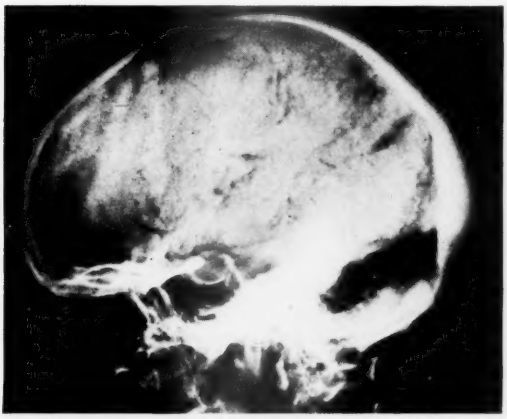


Fig. 1.—X-ray film of the skull in Case 3 showing a large defect in the occipital squama with sclerotic margins. A lumbar encephalography was performed which has filled the subarachnoid spaces over the convexity of the brain, but not the ventricles, with air.

In the early part of 1938, a radical mastoid operation was performed on the left side and more of the occipital bone was removed. A swab from the granulations revealed streptococcus hemolyticus and staphylococcus aureus. The dura of the posterior fossa was exposed to a large extent. After the operation, a delicate epidermis grew over the exposed dura. In the following months, the epidermis was destroyed on several sites by infection and fistulas were established leading into the space between the dura and the rest of the occipital squama.

I saw the patient on March 18, 1940, for the first time. There was a large defect in the skull (Fig. 1) which was covered by thin epidermis, the latter being perforated by four draining fistulas. There was a large retro-auricular fistula communicating with the middle ear, the latter being filled with pus, granulations and epidermis. Below the defect, in the left occipital bone, there was an extensive doughy swelling covered with normal skin, which reached mesially almost to the midline, forward to ascending portion of the mandible and downward to the level of the angle of the mandible. The swelling was due to a lymphostasis in the skin. There was no choked disk and the lumbar encephalography disclosed a filling of the subarachnoid spaces over the cerebral hemispheres, but there was no filling of

the ventricles (Fig. 1). The x-ray picture showed a marked thickening and densification of the walls of the bone defect indicating a cured osteomyelitis of the occipal bone (Fig. 1).

The further procedures consisted of the removal of the newly-formed epidermis and the exposure of the fistulas undermining the bone by further resection of the occipital squama. The resulting large defect was covered by skin flaps and the patient was cured. The patient has remained well ever since and gave birth to a child in September 1942.

Microscopic Examination. The removed bone chips consisted of lamellar bone containing many lines of arrested deposition, a few cement lines and very few haversian systems. There were many marrow spaces, the majority of them being filled with an osteoplastic connective tissue with many cells and dilated blood vessels. At the boundaries of these spaces there were osteoblasts laying down new lamellar bone and thus producing a narrowing of the marrow spaces. There were no osteoclasts and no signs of inflammation. In several marrow spaces the osteoplastic tissue was replaced by a mixed marrow containing fat tissue, lymphocytes and many eosinophiles.

Frequently the bone chips were covered by a typical osteophyte containing trabeculae of woven bone and between them an osteoplastic tissue with osteoblasts which lay down lamellar bone upon the trabeculae.

Comment. Having seen the patient in a late period of her illness, I am not able to give a definite description of the pathology. There are two possibilities: (1) she acquired an osteomyelitis of the occipital bone after the injury which during a period of 14 years advanced into the ear; or (2) the fracture of the occipital squama did not heal and was infected 14 years after the injury by an intercurrent otitis media resulting in a chronic osteomyelitis of the occipital squama. According to clinical experience, I am in favor of the second explanation. Presuming the explanation is correct, it is interesting to note that for a period of eight years, the osteomyelitis was limited to the occipital squama and did not produce a meningitis. It is noteworthy that despite the long-standing infection and probable arachnoid adhesions in the posterior fossa the plastic procedures were successful.

CASE 4—E. B., 70 years old, white, male. This patient complained of a nasal obstruction for many years. In 1936, a swelling of the left cheek, the left eye, and the left forehead was noticed. In

November 1937, a diagnosis of a tumor of the left maxilla was made, and in another hospital the left eye was removed, in order to facilitate the treatment of the tumor with radium. On June 27, 1938, a swelling the size of a small orange appeared over the right eye. The eyelids were edematous and there was a purulent discharge from the conjunctival sac. The left cheek was bulged out, but there were no palpable glands in the neck. The nasal septum was deviated to the right, the left nostril was filled with polypi which were partly removed with a marked subsequent hemorrhage. The microscopic examination of the polypi did not reveal any signs of a tumor. In the right nostril there was thick pus. The alveolar process of the maxilla was thickened and covered by a pale mucosa. On June 28, the abscess over the right eye was incised and fetid pus escaped. On July 21, there was a swelling over the left eye which was incised. Neither incision closed and the patient was dismissed with two draining sinuses above the eyebrows.

In the next months, the swelling of the cheek and the palate increased and he was re-admitted on August 26, 1938, when I saw him for the first time. On September 13, 1938, a large adenocarcinoma was removed which had replaced the entire maxillary and ethmoid sinus on the left side. The external carotid artery was exposed but not ligated.

The x-ray pictures revealed a cloudiness of both frontal sinuses, the walls of which were markedly sclerotic and indistinct. On September 21, a Riedel operation was performed on both sides. On the right side, there was a fistula approximately the width of a cherry stone in the lateral part of the supra-orbital arch, leading into the temporal recessus of the frontal sinus which was entirely separated from the rest of the frontal sinus. The anterior wall of the frontal sinus was fragile and necrotic. The sinus was filled with pus and granulations. In the lamina papyracea there was a fistula leading into the ethmoid which was filled with granulations. The lamina papyracea was removed, the ethmoid was curetted, the nasofrontal duct enlarged, and the wound left open. On the left side the same conditions were found except there was no fistula in the lamina papyracea. The removed granulations did not show any tumor elements.

During the convalescence there was fever and a marked proptosis developed on the right side combined with a marked diminution of vision and associated corneal ulcerations. During that time there were 136 mg. of glucose in the blood. However, all symptoms disap-

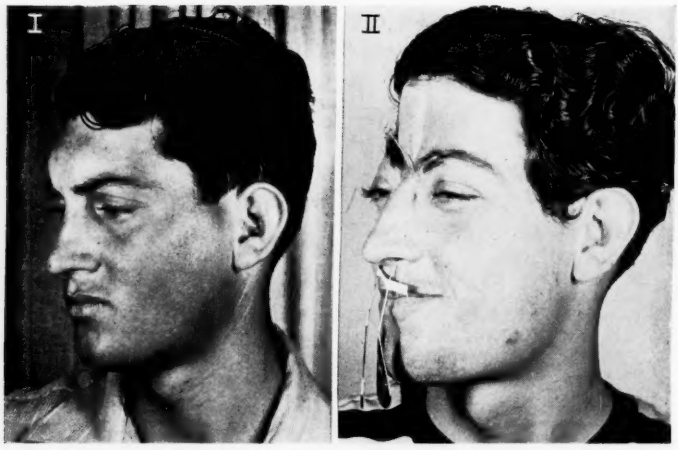


Fig. 2.—Showing the patient prior to the treatment and after the treatment. The two probes indicate the nasofrontal ducts which open above the bridge of the nose, the frontal sinuses having been removed.

peared and the large cavity in the maxilla was treated with radium. In October 1939, he noticed a redness of the skin below the orbit on the left side. This area was not tender and gradually turned into a draining sinus. A specimen for biopsy was taken and revealed a squamous-cell carcinoma of the scirrhous type. Treatment with x-rays and radium was administered and the carcinoma disappeared. Up to March 24, 1943, there was no recurrence of the tumor nor of the osteomyelitis, and the patient was even able to hold a job.

Comment. Although a microscopic examination of the bone was not done, the diagnosis of chronic osteomyelitis of both frontal sinuses can be scarcely doubted from the x-ray and surgical findings. There was also an osteitis of the right ethmoid with a fistula perforating the lamina papyracea. While fistulas in the eyebrows due to the osteomyelitis of the frontal sinuses is a common finding, fistulas in the lamina papyracea are rare. In this case a bilateral Riedel operation cured the osteomyelitis.

It is difficult to state the etiology of the osteomyelitis in the presented case. Many causes come into consideration, such as toxins originating in the tumor, radium, the obstruction of both nasofrontal ducts by the tumor, and the marked deviation of septum.

The combination of an adenocarcinoma of the maxilla and a squamous-cell carcinoma of the skin is noteworthy.

CASE 5.—C. H., 19 years old, white male. He was hit by a baseball in the summer of 1938. Approximately one year later, he noticed a drainage from the nose and a hard swelling appeared over the right side of the forehead. There was never any fever and only insignificant headache. In the summer of 1941 the headache increased markedly.

On admission, September 29, 1941, the patient was drowsy. There was a tumor the size of a plum at the glabella. This was covered with normal skin, was not tender or movable, and was of a hard consistency like an osteoma (Fig. 2). The nasal septum was deviated to the left. In the right nostril there was some pus and the right middle turbinate was pushed toward the septum. The mucosa of the right middle meatus presented a polypoid degeneration. There was a chronic pharyngitis, a chronic tonsillitis and the ear drums were retracted. The x-ray film (Fig. 3) showed a severe infection of the right frontal sinus but no osteoma. The blood Wassermann test was negative.

On September 30, a curved incision was made in the right eyebrow. The anterior wall of the frontal sinus was extremely thickened and it was very difficult to make an opening. In the sinus there was pus, edematous mucosa and some granulations. The posterior wall of the sinus was uneven. The sinus was much smaller than the x-ray film indicated. After enlargement of the nasofrontal duct the wound was closed and sulfathiazole was administered.

I saw the patient on October 3. His temperature was 100.2° F. and remained at about that level during the long period of his illness. He complained of headache. There was a moderate secretion from the wound and a profuse drainage from the nose. Both upper lids were swollen, but there were no meningeal symptoms. He was drowsy and there was tenderness over the forehead, particularly in the midline. The leucocyte count was 17,950. The neurological examination, including encephalography, was negative. On October 17, a very tender edema of the skin spread over the entire forehead, and in the right eyebrow there were two draining fistulas: one fistula in the center of the eyebrow, the other above the inner canthus, the latter leading into a duct of about 3 cm. in length between bone and skin.

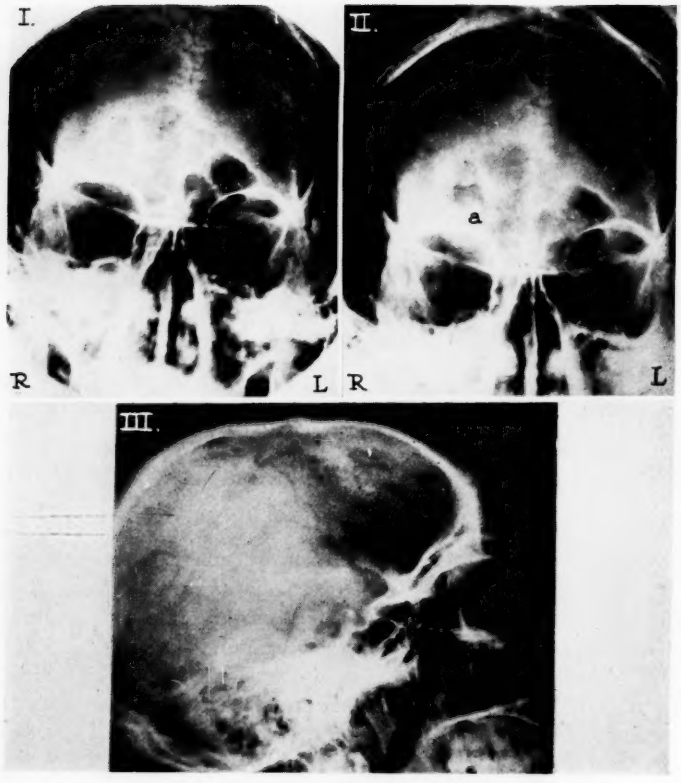


Fig. 3.—X-ray films of the frontal sinuses in Case 5. Film I was taken on July 25, 1941. Note the thickening of the floor of the right frontal sinus.

Film II was taken on October 13, 1941. *a* indicates the defect in the anterior wall of the right frontal sinus made at the first operation. Note the spread of the cloudiness of the frontal and ethmoid sinuses.

Film III was taken on October 17, 1941. Note the defect in the anterior wall and the thickening of the posterior wall of the frontal sinuses.

On October 18, under nitrous oxide anesthesia given intratracheally, a curved incision was made at the margin of the hair from one temple to the other and a perpendicular incision in the midline of the forehead was added. The two skin flaps were reflected. In the area of the right frontal sinus, there was a marked thickening and a black discoloration of the periosteum which upon microscopic examination was shown to consist of granulation tissue with many giant cells. A gutter was chiseled in the bone down to the dura reaching from one temple to the other (Fig. 4, I and III). The bone was of normal thickness in the lateral portions of the frontal squama, but it was more than 1 cm. thick above the glabella. The thickness was especially marked over the outer table, the diploe being normal and bleeding profusely. The granulation tissue was removed from the anterior wall of the right frontal sinus and a defect in the bone exposed. This opening was markedly larger than the one made at the prior operation. The right frontal sinus was filled with thickened mucosa and a little pus. The general condition of the patient did not permit the removal of the frontal bone. The curved incision at the hairline was closed tightly; the incision in the midline was closed by a few sutures.

Following the operation the patient still complained of headache and pain in the right malar bone. There was profuse secretion of pus from the midline incision. The leucocytosis fell to 14,000.

On November 1, under nitrous oxide anesthesia given intratracheally, the right skin flap was reflected. A severe hemorrhage resulted. The defect in the anterior wall of the sinus had extended further, was filled with granulations which had grown together with the skin. It was impossible to remove the frontal bone in toto; therefore, at first the anterior wall of the right frontal sinus was removed. After perforation of the interfrontal septum, pus containing streptococcus viridans escaped under pressure from the left frontal sinus. The mucosa of the left frontal sinus did not show definite pathology. The right half of the frontal squama was removed and the dura, covered with fibrinous exudate, was exposed beyond the midline. The sagittal sinus could not be identified. The orbital ridge and the floor of the right frontal sinus were removed. The incision in the midline was left open.

During the next few days the patient complained of headache, and the pain in the right malar bone increased. There was edema of both upper lids which, however, was decreasing on the right side.

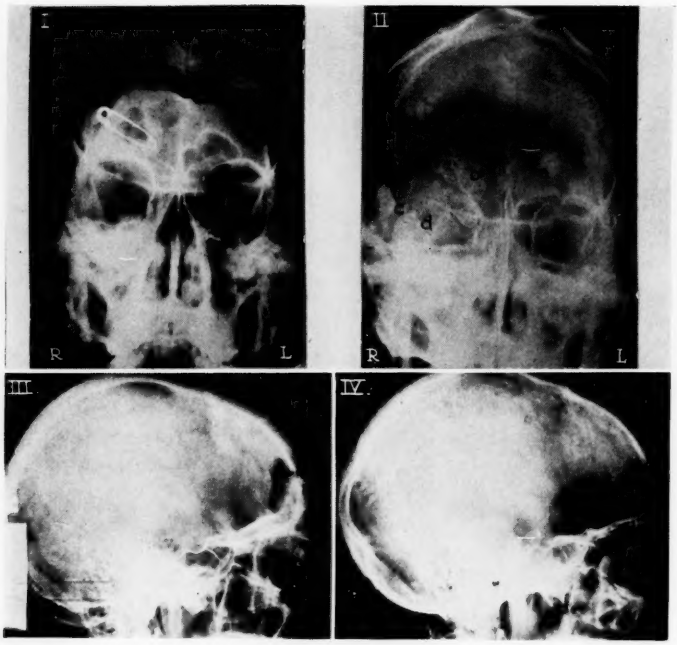


Fig. 4.—X-ray films of the skull in Case 5. Film I was taken on October 22, 1941. The osteomyelitic area is separated from the frontal squama.

Film II was taken on December 16, 1941. *a* indicates the posterior wall of the left frontal sinus; *b*, the gauze between the dura and the skin; *c*, the defect in the malar bone; *d*, the defect in the lateral wall of the right orbit reaching almost to the superior orbital fissure. The roof of the right orbit is absent. There is cloudiness of the right ethmoid and the right maxillary sinus; however, the margins of the frontal squama do not show osteomyelitis.

Film III was taken on October 30, 1941. The frontal sinuses are separated from the frontal squama. Note the thickening of the posterior wall of the frontal sinuses.

Film IV was taken on December 16, 1941. There is a large defect of the frontal bone. The frontal sinuses are removed.

November 8, under avertine anesthesia, the left portion of the frontal squama was exposed. The bone surrounding the left frontal sinus had a thickness of almost 2 cm. and was sclerotic. It was removed to a great extent. There was a large defect filled with granulations in the thickened anterior wall of the left frontal sinus. The anterior wall, the orbital ridge and the floor of the left frontal sinus were removed. The sinus, particularly the well-developed temporal recess, was filled with granulations, pus and polypi. The frontal process of the maxilla was removed to a great extent, but the posterior wall of the frontal sinus, being apparently normal, was left.

After the operation, the patient did not make a proper recovery and there was edema of the upper lid on the right side. Therefore, on November 18, a large subperiosteal abscess in the right temple was drained and the upper part of the ala magna of the sphenoid was exposed, presenting numerous bleeding spots. A horizontal incision was made toward the lateral angle of the right eye, and a sequestrum of the lateral part of the frontal squama and a portion of the malar bone were removed. The remaining part of the frontal squama and of the malar bone, a part of the ala magna and of the temporal squama down to the base of the skull were also removed. In the ala magna the marrow contained pus due to hemolytic staphylococcus aureus while in the temporal squama the marrow was anemic and contained small cysts. The dura as well as the periorbit were covered with fibrinous exudate; below the removed sequestrum, there were granulations on the periorbit.

In the next few days he complained of tinnitus on the right, which disappeared after treatment of an acute serous catarrh of the middle ear. There was severe pain over the nasal ridge and above the right internal palpebral ligament; an abscess the size of a cherry extended into the mesial portion of the right upper lid.

On November 25, the left ethmoid was drained by an external approach. Pus escaped under pressure and the edematous mucosa was removed. On the right side, the frontal process of the maxilla was thickened, causing a narrowing of the piriform aperture on that side. A part of the frontal process, together with the lacrimal bone and a part of the lamina papyracea, was removed. There was no pus in the right ethmoid, but much of the mucosa was edematous. The mesial part of the floor of the right frontal sinus was very thick and was removed. According to these findings, the abscess in the inner angle of the right eye was not due to an ethmoiditis, but to an osteomyelitis of the remnant of the floor of the frontal sinus.

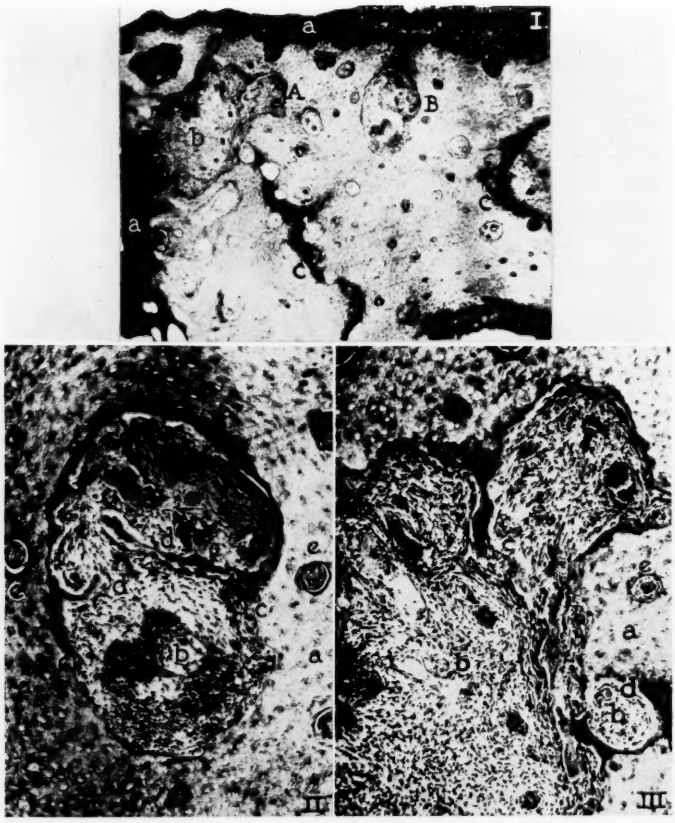


Fig. 5.—Photomicrographs, taken on November 8, 1941, of bone from the left frontal sinus. In picture I the bone consists chiefly of woven bone. The osteocytes are absent to a great extent. The margins of the bone are covered by granulation tissue *a* which invades the bone in *b*. In the small marrow spaces there is a marked deposition of bone leading to an osteosclerosis. *c* indicates the basophilic islands of Zawisch-Ossenitz. The marrow spaces *A* and *B* are shown in the following pictures under higher magnification.

Picture II presents the marrow space *B* of Picture I. The lower portion of the marrow space presents numerous Howship's lacunas which are covered by osteoblasts. The margins of the upper portion of the marrow space consist of osteoid tissue which is calcified to a certain extent. In *c-c* are the boundaries between the two portions of the marrow space. *b* indicates a recent hemorrhage; *d*, bone trabeculae, partly calcified; *e*, a blood vessel space surrounded by a thick line of arrested deposition and osteoid substance adjacent to that line.

Picture III presents the marrow space *A* of Picture I. *a* indicates woven bone; *b*, osteoplastic tissue; *c*, bone trabeculae; *d*, osteoid tissue; *e*, small blood vessel space the margins of which are covered by osteoblasts and osteoid tissue.

After the operation improvement was noticed. The patient was alert and slept without sedatives. However, there was still a marked edema of the right upper lid, and a tender edema of the right temple and the right cheek, extending toward the nose. The x-ray film showed a thickness of the lateral wall of the orbit.

On December 6, the incision in the midline of the forehead was partly closed and a Kroenlein operation was performed on the right side. Behind the remnants of the superior margins of the orbit there was a fistulous tract running behind the fascia temporalis and the temporal muscle and leading into the temporal fossa. The fat tissue, fascia and muscle were incised and the lateral and superior walls of the orbit, forming sequestra and being bare of periosteum, were exposed. The superior portion of the lateral orbital wall up to the superior orbital fissure and more of the ala magna, constituting the floor of the middle cranial fossa, were removed. The exposed dura was normal (Fig. 4, II and IV). After the operation a rapid general improvement ensued, but there was still much secretion from the midline incision in the forehead.

On December 20, the posterior wall of the left frontal sinus, which was surrounded by granulations, and a part of the floor of the left anterior cranial fossa were removed. Both nasofrontal ducts were open. Seven months later both ducts were found to be closed. Therefore, they were reopened and covered with Thiersch flaps.

The patient made an uneventful recovery and was dismissed with a marked deformity of the skull. There was no recurrence of osteomyelitis up to March 1943, when he went back to work.

Microscopic Examination. Mucous Membrane and Anterior Wall of Right Frontal Sinus (September 30, 1941). The mucosa consisted of granulation tissue and connective tissue without epithelium. In the connective tissue a metaplastic ossification took place resulting in the production of trabeculae of primitive woven bone covered by osteoblasts and some osteoclasts. The bony wall consisted of typical agate bone with three or four lines of arrested deposition and was covered by osteoblasts and periosteum. That bone passed gradually over into a very compact woven bone with a few blood vessels. There were very few osteocytes in the primitive bone, but the osteocytes of the newly-formed bone trabeculae were normal.

Soft Tissue and Anterior Wall of the Right Frontal Sinus and Right Half of the Frontal Squama (November 1, 1941). Macro-

scopically the bone was porous. Microscopically, the bone consisted of haversian systems and between them areas of woven bone. The osteocytes were largely absent. There were many haversian blood vessels and haversian spaces surrounded by a blue "Grenzscheide," causing the macroscopic impression of porosity. Some of these spaces were filled with pus or granulation tissue, the latter harboring osteoclasts which destroy the "Grenzscheide" as well as the adjacent bone. The soft tissue consisted of granulation tissue without epithelium.

Left Frontal Sinus (November 8, 1941): The mucosa consisted of an edematous, hyperemic tissue with infiltrations of a firm connective tissue. The columnar epithelium did not contain goblet cells and the basement membrane was thickened.

The anterior wall contained compact agate bone and haversian systems and there was some apposition of bone on the outer surface. Other bone chips consisted of compact woven bone devoid of osteocytes (Fig. 5). Within the bone there were large marrow spaces containing an osteoplastic tissue which produces primitive bone trabeculae by metaplastic ossification and a woven bone by activity of osteoblasts at the margins of the marrow spaces. The study of many bone chips revealed the fusion of the bone trabeculae to form a compact layer of woven bone. Almost all bone chips showed formation of new bone which took place so rapidly that the blood vessels became compressed and the nourishment of the newly formed bone was insufficient. Therefore, the osteocytes became necrotic to a great extent.

Right Ala Magna of Sphenoid (November 18, 1941). There was a typical acute osteomyelitis.

Lateral Wall of the Right Orbit (December 6, 1941). There were the same findings as in the right half of the frontal squama examined on November 1.

Posterior Wall of the Left Frontal Sinus and Floor of the Left Anterior Fossa (December 20, 1941). There was no inflammation. The original wall of the frontal sinus consisted of normal agate bone, which on both surfaces was covered by newly formed woven bone forming an osteophyte. The osteophyte consisted of bone trabeculae which formed a network containing an osteoplastic fibrous tissue. As the osteoblasts laid down new bone on the surface of the trabeculae, the latter gradually fused and formed a compact layer of newly formed woven bone with several small marrow spaces; this

is in contradistinction to the lamellar bone of the original sinus wall. At other places there were empty spaces between the trabeculae of the osteophyte. Perhaps that finding is artificial.

The boundaries between the osteophyte and the original bony wall of the sinus consisted of a blue line of arrested deposition which distinctly separated the two layers of bone. In some places there was a more gradual fusion of the original lamellar and the newly formed woven bone. Frequently the osteoplastic tissue filling the marrow spaces of the woven bone invaded the lamellar bone of the sinus wall forming large grooves, the margins of which were pitted by Howship's lacunae. Osteoclasts were absent; the margins of the grooves were either covered by osteoblasts or they were aplastic.

The interpretation of these findings is not difficult. There was a chronic proliferative inflammation of the dura as well as of the mucosa of the sinus. The granulation tissue produced by the chronic infection invaded the bony walls, causing an osteitis and an osteomyelitis. At the time of the operation the granulation tissue had turned into an osteoplastic connective tissue and had formed an osteophyte by metaplastic ossification as well as by the activity of osteoblasts. The erosions of the original wall of the sinus were being refilled by a newly formed woven bone.

Comment. The presented case is interesting because it was possible to check the progress of an osteomyelitis which was spreading along the vault as well as the base of the skull. According to the history it is a case of slowly developing, chronic osteomyelitis following traumatism. The osteomyelitis led to a thickening of the anterior walls of the frontal sinuses which gave the appearance of a tumor, and to headache which made the patient drowsy. In order to give the patient some relief from his headache an exploratory opening of the anterior wall of the right frontal sinus was made by another rhinologist. The operation met with considerable difficulties as the sinus wall was extremely thick. Within the sinus pus, granulation tissue and a swollen mucosa were found.

Three days after the operation there was an elevation of the temperature; headache, drowsiness, edema of both upper lids, leucocytosis, a spreading edema over the forehead, and two fistulas in th right eyebrow developed. All these symptoms pointed to a fulminating, spreading osteomyelitis, which required the removal of almost the entire frontal bone together with both frontal sinuses, a great part of the right ala magna of the sphenoid, a part of the right

malar bone, a small part of the right temporal squama and of both ethmoids. It was only after these considerable surgical procedures that the spreading of the osteomyelitis could be checked and the patient cured. It is noteworthy that about two years later a great part of the frontal squama has regenerated.

From the pathological point of view it is interesting to note that the finding of a typical acute and destructive osteomyelitis was obtained only in the right ala magna. On all other sites there was either osteogenesis resulting in the formation of a primitive, woven bone, or necrosis due to the infection and to the over-formation of bone with subsequent compression and obliteration of the blood vessels.

CASE 6.—S. N., 55 years old, white, female. For five years she had complained of headache localized in the forehead. The pain increased at night and decreased when she sat up. For one day she noticed mucopurulent discharge from the nose.

On admission, January 6, 1941, there were polypi and pus in the right middle meatus. A puncture of the right maxillary sinus revealed fetid pus. The Wassermann test of the blood was negative. On February 14, a Caldwell-Luc operation was performed, followed by an uneventful recovery.

On March 27, 1941, she still complained of pain in the right maxilla and in the right temple, so severe it disturbed her sleep. In the right middle meatus there were polypi and thick pus. The x-ray picture on April 16 (Fig. 6) showed a marked haziness of the right maxillary and the right ethmoid sinuses. The right frontal sinus was cloudy, the boundaries were indistinct and there was a definite sclerosis in the temporal recess of the sinus. There was an abrupt end of the haziness at the midline of the fontal area. The left frontal sinus seemed to be very small and somewhat cloudy. On April 17, an endonasal ethmoid operation was performed on the right side. The ethmoid was filled with polypi and hyperplastic mucosa.

The patient continued to complain of headache, which by November 5 had decreased slightly. However, there was intense tinnitus in the right ear, she had a cachectic appearance and the x-ray picture, taken on December 15, showed practically the same findings as the film taken on April 16.

On January 2, 1942, there was tenderness over all exits of the trigeminal nerve on the right side and the right supra-orbital ridge

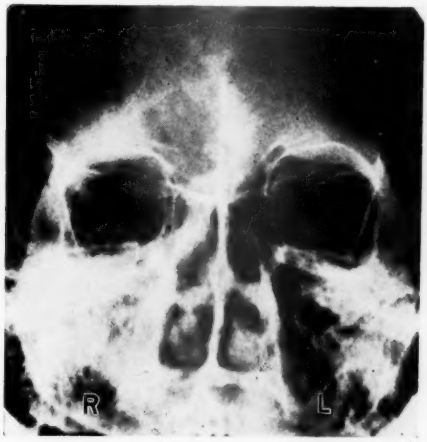


Fig. 6.—X-ray film of sinuses in Case 6 taken on April 16, 1941. Note the sclerosis in the area of the frontal sinuses, particularly in the temporal recess of the right frontal sinus.

seemed to be thickened. The nasal mucosa was dry; no polypi, no pus could be seen and the right ethmoid was widely open. There was definite cachexia and a marked tinnitus on the right side although the right drum was normal. There was only a moderate degree of inner ear involvement on the right side; the left inner ear was more affected. The labyrinths were normal. Further surgery was refused by the patient.

In November 1942, the patient still complained of headache and tinnitus, and there was thick pus in the anterior part of the left middle meatus. Irrigation of the frontal sinus did not produce any pus and the x-ray picture did not present any further progress of the disease.

In April 1943, there were the same complaints. There was no pus in the right nostril and irrigation of the right frontal sinus did not produce any pus.

Microscopic Examination. The mucosa of the right maxillary sinus was markedly thickened by an infiltration of lymphocytes and an increase of connective tissue. There were almost no polymorphonuclear cells. The epithelium was either columnar with a few goblet cells or it was transitional. Small chips of bone were em-

bedded in the connective tissue. The bone chips showed Howship's lacunae and occasionally osteoclasts; in other words, they were in the process of being resorbed.

The bony wall of the sinus consisted of trabeculae, between them being either slightly inflamed fibrous tissue or fat marrow with many blood vessels. In the first case the trabeculae were frequently covered by osteoblasts, occasionally lying within Howship's lacunae, while osteoclasts were in the minority. In the latter case the surface of the trabeculae was either aplastic or covered by osteoblasts. On many sites the bone trabeculae grew together and formed a bony plate consisting of lamellar bone with many lines of arrested deposition and marrow spaces. The boundaries of the marrow spaces were covered by osteoblasts indicating that the marrow space was going to become narrower.

The mucosa of the right ethmoid showed an inflammation which destroyed several glands. The bony septa showed in general the same changes that had been found in the wall of the maxillary sinus.

Comment. The presented case gave, at first, the impression of a simple chronic infection of the maxillary sinus on the right side. However, the foul odor of the pus in an edentulous patient and in the absence of retention, the severe pain and the cachexia pointed to an inflammation extending into the bony walls of the sinus. As a matter of fact, the microscopic examination proved there was a severe inflammation of the mucosa extending into the bone and causing a chronic osteomyelitis.

As the headache continued and severe tinnitus in the right ear was noticed after the operation, an x-ray study of the sinuses was made. This showed an ethmoiditis on the right side and a chronic osteomyelitis of both frontal sinuses. An endonasal ethmoid operation was performed on the right side, but the patient refused any surgery upon the frontal sinuses. The microscopic examination of the right ethmoid revealed the same findings as in the maxillary sinus.

Considering the headache, the tinnitus and the x-ray picture a chronic osteomyelitis of the frontal sinuses cannot be doubted. It is noteworthy that for more than one and a half years the osteomyelitis remained stationary, and that during that time the nasofrontal duct remained open and irrigation of the frontal sinus did not produce pus in any considerable amount.

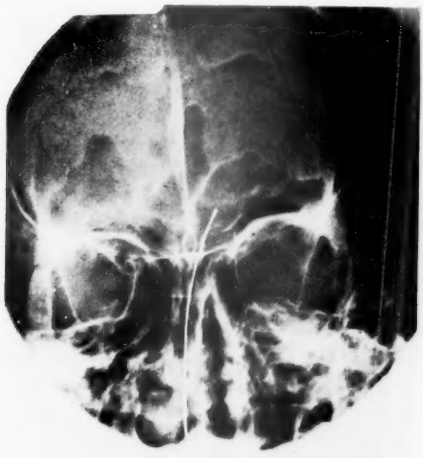


Fig. 7.—X-ray film of the frontal sinuses in Case 7. Note the probe passing from the right nostril into the left frontal sinus, the cloudiness and indistinct margins of the right frontal sinus, and the formation of sequestra in the right frontal sinus area.

CASE 7—D. P., 55 years old, white, male. In 1914 he had a cold with marked discharge from both nostrils, particularly from the right. In 1923 both frontal sinuses were opened from the outside. Nevertheless, he suffered further from frequent colds and from severe headache, particularly in the right forehead. Therefore, in 1939 he went to Dr. I. Spiesman who treated him conservatively. The pain disappeared when the nose was discharging, but there was no definite improvement. In February 1941, a marked swelling appeared over the right eye and he was operated on by Dr. Spiesman, who removed a sequestrum from the right ethmoid. Following that operation he felt well until February 17, 1943, when he suddenly noticed pain in the right forehead and a swelling over the right eye. There was no discharge from the nose.

I saw the patient on February 18 for the first time. His temperature was 98° F. He was pale and looked ill. There was a scar in the right eyebrow and a slight defect in the right supra-orbital arch. There was edema over the right eye extending toward the forehead for about 3 cm. The edema extended mesialward over the glabella and the bridge of the nose but did not extend into the left eyebrow. Lateralward the edema extended to the lateral angle of

the eye and stopped there with a sharp line. The edema was particularly marked in the lateral part of the right upper lid. The conjunctiva and the movements of the eyes were normal. The edema was markedly tender, but the skin was not red. The left nostril was normal. In the right nostril there was thick pus in the middle meatus. After removal of the pus the following findings were noted: The inferior turbinate was normal. The middle turbinate was partially removed and the bulla ethmoidalis exposed.

X-ray examination showed the frontal sinus to be very large, the temporal recess being particularly developed. While the entire right frontal sinus was cloudy, only the mesial portion of the left frontal sinus was hazy. The boundaries of the left frontal sinus were distinct, but the boundaries of the right frontal sinus were definitely indistinct. The anterior wall of the sinus was thickened and showed small areas of destruction. The posterior wall of the sinuses were normal. There was some cloudiness of both maxillary sinuses, particularly on the left side. A probe introduced into the right nostril easily entered what seemed to be the right frontal sinus. An x-ray film, taken with the probe in situ, proved however, that the probe was not in the right frontal sinus but in the left frontal sinus (Fig. 7). Consequently, the following diagnosis was made: destruction of the floor of the left frontal sinus and perforation of the upper part of the lamina quadrangularis and the lamina perpendicularis.

Conservative treatment (sulfathiazole and heat) was administered. The swelling on the forehead turned into an abscess which was incised. No bacteriologic finding of the pus was obtained. The patient made an uneventful recovery, but several weeks later the pain and the swelling returned. The patient refused surgery and was dismissed.

In June 1943 all symptoms reappeared and again disappeared following conservative treatment. The patient again refused surgery.

Comment. The history of the patient does not furnish exact data. Nevertheless, the following phases of the disease can be reconstructed: The patient became ill with an acute sinusitis in 1914. The acute sinusitis turned into a chronic sinusitis, which gradually invaded the bone and caused a chronic osteomyelitis. The outstanding symptom was severe headache, particularly in the right forehead. Nine years after the onset of the disease an operation was performed on both frontal sinuses. Unfortunately it was not pos-

sible to get any information concerning the type of operation, but it can be assumed that the operation was not a radical one and, therefore, had no success and the headache continued. Twenty-seven years after the onset a swelling appeared over the right eye due to a sequestrum in the right ethmoid. Another operation was followed by temporary relief for two years. Again a swelling over the right eye was noticed, extending toward the lateral angle of the eye and toward the glabella. The x-ray examination revealed a definite osteomyelitis of both frontal sinuses, particularly the right, involving chiefly the anterior walls of the sinuses. Furthermore, there was a fistula in the floor of the left frontal sinus and in the uppermost part of the nasal septum. This furnished drainage of the left frontal sinus into the right nostril. This finding points to the importance of taking x-ray pictures with the probe in situ.

The patient refused surgery. Conservative treatment was administered and gave him temporary relief.

SUMMARY

Etiology. The etiology of the osteomyelitis in the presented cases varies considerably. In Case 1 it was probably due to erysipelas of the skull, in Case 2 to scarlet fever, in Case 3 to a head injury, in Case 4 to an adenocarcinoma of the paranasal sinuses with subsequent obstruction of both nasofrontal ducts, in Case 5 to an injury of the skull, and in Case 6 and 7 to a pansinusitis. Therefore, in chronic osteomyelitis of primary type acute infection of the paranasal sinuses is, so far as the etiology is concerned, less important than in acute osteomyelitis.

The notes concerning bacteriology are rather poor. From my cases four bacteriological findings were obtained. In Case 1 the pus of a probable metastasis did not contain aerobic bacteria; in Case 3 hemolytic streptococcus and staphylococcus aureus were found; and in Case 5 the pus in the frontal sinus contained streptococcus viridans and the marrow staphylococcus aureus hemolyticus. In several of Skillern's[3] cases staphylococcus aureus was found; in one of his cases no bacteria grew on culture. Therefore, it seems that in chronic osteomyelitis staphylococci play a similar part as in the acute type. However, it is noteworthy that frequently no bacteria grew on culture. This finding might be explained by the investigations of Galloway,[4] who stresses the importance of anaerobic and microaerophilic streptococci in infections about the head. Significant for that type of infection were its spread in soft tissue and its persistence

over long periods of time. Although in our cases the infection did not spread in soft tissue, in the future it will be necessary to consider anaerobic infection in these instances in order to define exactly the part played by these bacteria.

Clinical Course. Chronic osteomyelitis of primary type is chiefly characterized by its insidious onset and by its poorly marked tendency to spread.

As the disease never sets in with such alarming symptoms as fever, chills or a severe headache (which are rather characteristic for acute osteomyelitis) the patients can indicate the onset only approximately. In three cases the onset was indicated by an abscess developing gradually in ten days to two months over one or both eyes, without marked fever, without marked localized pain and without leucocytosis. In none of these instances was the frontal sinus involved. The abscess was incised; however, the incision did not close and a draining fistula was established. In Case 3, in which there was osteomyelitis of the occipital bone, the abscess extended gradually over the occiput and, from the very onset, was accompanied by low-grade fever of about 101° F. and moderate headache. However, in that case there was a fracture of the bone which became infected from the ear, and thus, an early involvement of the dura comes into consideration.

In the four instances in which the osteomyelitis originated in the frontal sinus there was no abscess at the onset of the disease, although the anterior wall of the sinuses were particularly involved. If in these instances an abscess developed, it did not occur at the onset but in the late stage of the disease, viz., 2 years (Case 4) or 27 years (Case 7) after the onset. There was rather a gradual development of severe headache and toxemia which were accompanied by the formation of a bony tumor over the frontal sinuses (Case 5). Skillern[3] emphasizes that the toxemia affects chiefly the nervous and gastro-intestinal tracts.

Pathology in the nose was found if the disease originated in the paranasal sinuses or if these spaces were involved secondarily. Skillern found only hyperplastic changes in the nasal mucosa. We found pus and polypi in the middle meatus in Cases 2, 4, 5, 6 and 7. It is important that, in spite of a long-standing osteomyelitis, the naso-frontal duct in Case 6 was patent and irrigation of the sinus did not produce pus. Very interesting was the finding of a fistulous tract in the uppermost part of the septum and in the floor of the left frontal sinus, leading from the right nostril into the left frontal sinus (Case

7). In instances in which the frontal sinus was not involved (Cases 1, 2, 3) the progress of the disease terminated in the formation of a sequestrum which remained unchanged for three and one half years (Case 2). A definite spreading was never noticed in these instances. Only in Case 3 was there a slow spreading; however, in that case a fracture of the temporal bone was present and the spreading took place over a period of six years.

In instances in which the frontal sinus was involved (Cases 4, 5, 6, 7) the termination of the osteomyelitis was different. It consisted of the formation of a fistula in the anterior wall of the frontal sinuses (Case 4), of a thickening of the anterior wall of the frontal sinus (Cases 5, 6) and of the formation of a sequestrum (Case 7). In Case 7 the formation of the sequestrum took place 27 years after the onset of the disease, while in instances without involvement of the frontal sinuses the sequestrum was formed several weeks or months after the onset of the disease. A definite spreading over the limits of the frontal sinus was not noticed even after several years of observation.

Pathology and Roentgenology. While in the instances in which the sinuses were not involved the osteomyelitis developed along the course of the blood vessels, the primary type of chronic osteomyelitis of the paranasal sinuses requires some comment.

There is some controversy concerning the question of whether or not the frontal sinuses have a special wall, that is, a layer of compact bone which separates the mucosa from the diploe of the frontal bone. The investigations of Sitsen[5] seem to give a definite answer. Under normal circumstances the frontal sinuses grow to the twentieth year of life. In that period there is marked osteoclasis and osteogenesis in the bony walls of the sinus, the former originating particularly in the mucosa of the sinus (leading to a dilatation of the sinus), the latter originating particularly in the marrow spaces. While the individual is growing the osteoclasis decreases and the osteogenesis increases, bringing about the formation of a layer of compact bone which has a thickness of 200 to 300 μ and which separates the mucosa of the frontal sinus from the diploe. Although that marginal compacta might be covered by active osteoblasts even in very old people, it does not change its thickness conspicuously.

In common infections of the paranasal sinuses, particularly in chronic cases, the bony walls are covered by osteoblasts which form new bone. Osteoclasts or other forms of bone resorption are almost never seen. Thus, the common infections of the sinuses are accom-

panied by a superficial osteitis, characterized by definitely prevailing osteogenesis and eventually leading to a thickening and sclerosis of the bone. In other words, the superficial osteitis presents essentially the same changes in the bone as can be found in adults without infection; the changes are only more marked in the former case and are due to an infection.

The marginal osteitis in common sinusitis is without clinical significance. If, however, strains of bacteria penetrate deeper into the marrow, the clinical entity of osteomyelitis is established. In the course of osteomyelitis, the bone resorption may prevail over the bone deposition as in acute osteomyelitis, or the contrary relationship may take place as in chronic osteomyelitis of primary type. In the latter event hyperostosis and osteophytes may develop in the frontal, maxillary and sphenoid sinuses,[22] or there may develop hyperostosis of the frontal squama (Henschen[6] and Case 5) or a total or partial obliteration of the frontal sinus as described by Skillern.[3] The obliterative frontal sinusitis of Skillern, which probably is similar, if not identical, to the disease "Spongiosierung der Stirnhoehlen," described by Preysing[7] in 1911, consists of a thickening of the anterior wall of the frontal sinus resulting from a bacterial or a traumatic stimulus or both. In Case 5 the thickening and sclerosis involved all walls of the sinus, even the frontal squama; however, the anterior wall was particularly involved. The thickening was due to an osteophyte which was added to the original bone before or after the partial resorption of the latter. This is analogous to the osteoplastic type of osteomyelitis of the long bones. It seems certain that the chronic osteomyelitis of primary type generally develops in the anterior wall of the frontal sinus.

The described findings, so far as the frontal sinuses are concerned, appear on the x-ray films. The normal frontal sinus of adults is bounded by a broad line which has double contours and presents the marginal compacta. In roentgenologic terminology, the margins of the frontal sinus are distinct. The margins of the small frontal sinuses in children and in young adults are partially indistinct under normal circumstances (Loew-Beer,[8] Psenner[9]), indicating the absence of a marginal compacta. This is in agreement with the histological findings mentioned above. Therefore, in instances of a small frontal (or sphenoid) sinus a partial indistinctness of the boundaries does not necessarily indicate pathology of the bone even if there is a slight haziness of the sinus, the latter finding being due to the small diameter of the sinus.

In chronic sinusitis a fuzzy appearance of the boundaries and a sclerotic area particularly at the lateral and superior angles of the frontal sinus frequently can be observed (Uffenorde,[10] Loew-Beer,[8] Grier,[11] Kos,[12] Macmillan,[13] Kornblum and Hodes,[14] Psenner[9]). This finding indicates a marginal osteitis provided the sinus has reached its complete development and is definitely cloudy.

In actual chronic osteomyelitis all these changes reach a climax. The outlines of the sinus become not only indistinct, they may disappear entirely; and due to the thickening of the anterior wall, the area of the frontal sinus is replaced by a sclerotic area which gradually passes over into the frontal squama and occasionally ends abruptly in the midline of the frontal area, as emphasized by Preysing[7] and Skillern.[3] Frequently the report of the radiologist indicates a failure of development or an absence of one frontal sinus in these instances.

Treatment. In instances in which the frontal sinuses are not involved and the chronic osteomyelitis leads to the formation of a sequestrum after several weeks or months, the sequestrum should be removed. The disease spreads very slowly, if at all, and usually does not penetrate into the brain although we found in the case of a child (Case 2) an arachnoidal cyst beneath the sequestrum. Thus, in these cases, one can wait for the formation of a sequestrum. Cases 1, 2, and 3 were treated and cured by that method.

Instances in which the frontal sinus is involved and which lead after several years to the formation of a sequestrum or fistula also do not meet with great difficulties as far as the treatment is concerned. In these cases the Riedel operation must be the method of choice. Case 4 was treated and cured by that method. The patient described in Case 7 refused the operation but one can expect that he finally will submit to surgery.

Difficult to answer is the question of what to do with cases of primary chronic osteomyelitis which involves the frontal sinus and presents a thickening and sclerosis of the walls, particularly of the anterior wall, which, however, does not give rise to either sequestra or fistulas. Skillern,[3] in his cases, has performed an external operation with good success. In my experience the conditions are as follows: the osteomyelitis of these cases may continue for years without leading to an intracranial complication. Thus, there is no emergency. The immediate purpose of surgery is to relieve the patient of pain and toxemia. In order to achieve that purpose one must keep in mind that he is not dealing with a common sinusitis or with

pus within the sinus, but with a disease located within the bony walls of the sinus. It is characteristic in osteomyelitis of the frontal sinus for the x-ray picture to present a definite cloudiness while the properly performed irrigation of the sinus does not produce any pus or only a small amount of pus (Case 6). Therefore, one has no reason to perform an operation which simply enlarges the nasofrontal duct inasmuch as the duct is frequently patent anyway. One also has no reason to perform an opening in the anterior wall of the sinus as was done in Case 5 by another rhinologist. That procedure is even dangerous.

One must keep in mind that the bone, newly formed by the primary chronic osteomyelitis, is, to a great extent, primitive woven bone containing very few blood vessels. This bone may become obliterated so that it cannot be considered a dependable barrier against infections. One must further keep in mind that in the marrow spaces of the original or newly formed bone the bacteria may lead a "hibernating" existence and may become irritated due to insufficient surgery, as happened in Case 5. Askanazy[21] mentions the presence of staphylococci in the marrow for 40 years without evidence of clinical symptoms.

Thus, there remains only one way to eliminate the pain and the toxemia and that is the operation after the technique of Riedel or Kuhnt. The operation is rather difficult as the bone is thick and the lumen of the sinus small. The deformity after the operation is marked if a Riedel operation is performed, less marked if a Kuhnt operation is performed. Therefore, the decision must be made in every single case as to whether or not the patient is willing to undergo all these risks in order to be free of pain and toxemia. In Case 6 the operation was refused; in Case 5 the operation was absolutely indicated.

CHRONIC OSTEOMYELITIS OF SECONDARY TYPE

REPORT OF CASES

CASE 8.—M. P., 21 years old, white, female. During 1939, about one week after swimming, this patient developed a swelling beneath the right eye and on the jaw. After one day the swelling involved the inferior auricular region. A few days later the left eye became swollen and tender and the left side of the face was somewhat swollen. There was fever up to 103° F. She was in the hospital for one month and conservative treatment was administered. On September 1, 1939, a "drainage" was performed on the

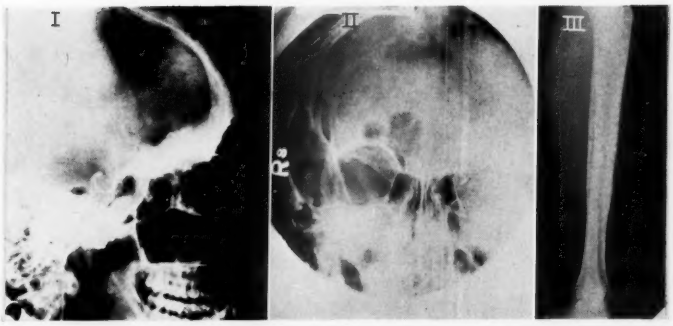


Fig. 8.—X-ray films of Case 8. Film I was taken on March 3, 1942. There is a large defect in the temporal area while the rest of the bone is sclerotic and thickened by newly formed bone.

Film II was taken on the same day. Both frontal sinuses are cloudy, the left more than the right. The boundaries of the left frontal sinus cannot be recognized because of the thickening and the sclerosis of the bone. The sclerosis and the thickening extend into the frontal squama, into the left malar bone, into the great wing of the left sphenoid and into the lateral wall of the left maxillary sinus. The left superior orbital fissure is narrowed.

Film III, taken on the same day, presents the metastatic osteomyelitis of the right tibia.

left frontal sinus and several sequestra were removed from the skull. Three weeks later the same procedure was performed on the right side. In 1940 a draining sinus developed gradually above the lateral angle of the left eye. In July 1940 a sequestrum was removed from that area. On September 9, 1941, a second sequestrum was removed from the same place. In January 1942 a third sequestrum was expelled spontaneously from that area. At present, she complains of pain in the surrounding region and behind the left eye, and of a scanty secretion from the fistula above the lateral angle of the left eye. The pain is intermittent, not very severe and radiates from the left cheek upward.

I examined her on March 28, 1942, for the first time. She was a well-nourished girl. The skin of the face was pale with a slightly yellowish tint, the temperature was normal and the Wassermann reaction in the blood was negative. There were scars bilaterally at the hairline extending down to the eyebrows at the midline. However, there were no scars which would have indicated that a radical

operation was performed. There was a depressed area in the outer angle of the left eye and in that area there was a slightly draining fistula. There was another scar extending from the right side of the forehead backward toward the ear and there was a similar scar on the left side extending backward to a defect in the left parietal bone. Small scars were found in the depressed area over the outer angle of the left eye and in the center of the forehead. There was no tenderness of the skull.

The ear drums were retracted and there was a moderate loss of hearing on the right side. The nasal septum was deviated to the left and there was mucopus in the right middle meatus. The blood did not present any conspicuous pathology. There was a slight proptosis of the left eye which was lower than the right. The left malar bone was bulged out. In the area of the frontal sinuses there was no defect whatsoever. The right frontal sinus could be easily probed; the left frotal sinus could not.

The x-ray picture (Fig. 8) revealed a marked cloudiness of the left frontal sinus, the cloudiness ending rather abruptly in the midline. The boundaries of the sinus were indistinct. The right frontal sinus was large and hazy. The boundaries were fairly distinct. Both frontal sinuses were surrounded by a sclerotic area which extended toward the left maxilla, the left malar bone and the left great wing of the sphenoid. Due to that extensive sclerosis there was a narrowing of the left superior orbital fissure and the left maxillary sinus. Both ethmoids and sphenoids were hazy and there was a marked cloudiness of the right maxillary sinus. There were several spots in the skull where the outer table and the diploe were replaced by sclerotic bone, the latter presenting many spots of translucency and few small sequestra. The inner table was intact. There was a thickening of the posterior walls of the frontal sinus and of the roofs of the orbits extending into the anterior clinoid processes (Fig. 8).

As the patient complained of pain in the right leg, an x-ray picture was taken and revealed a spindle-like thickening of the cortex of the right tibia with narrowing of the central marrow space (Fig. 8). Within the thickened area there was a spot of translucency, the size of a pea. A diagnosis of metastatic osteomyelitis of the right tibia was made.

As there was no urgent indication for surgery, the patient was dismissed; however, she came back on August 4, 1942, complaining of a second fistula which had developed in the center of the left

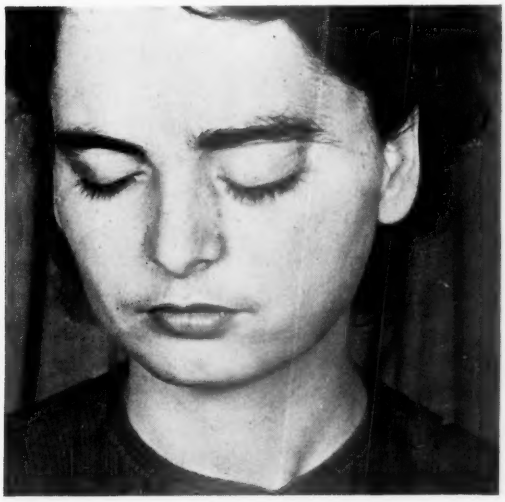


Fig. 9.—Showing Case 8 after treatment. The scar below the left eyebrow is scarcely visible and there are no fistulas in the eyebrow. Note the diffuse swelling in the area of the left malar bone.

supra-orbital arch and through which small sequestra were expelled. As the activity of the osteomyelitis could not be doubted and the patient insisted on a more radical procedure, on August 8 a radical operation was performed on the left frontal sinus according to the technic of Jansen-Ritter. The periosteum on the supra-orbital arch had changed into granulations and scar tissue so that the exposure of the bone was difficult. The ethmoid was opened and was found to be normal. The floor of the frontal sinus was almost five times thicker than normal; this was removed but the anterior wall was left. The frontal sinus was large and presented a temporal recess which was almost completely separated from the sinus. There was no pus and most of the mucous membrane of the sinus appeared normal. Only in the area of the nasofrontal duct and in the temporal recess were there polypi. The lateral angle of the frontal sinus was enormously thickened, but there were no sequestra. A large opening was made through the ethmoid into the nose. The skin incision was extended toward the fistula above the outer angle of the eye. The fistula led into a sulcus on the mesial surface of the thickened malar bone which was filled with granulations and ran about 1.5 cm. into the depth of the orbit. The sulcus with the surrounding bone was

removed and the skin incision was closed except in the area of the fistula.

There was an uneventful recovery except for a marked edema of the left upper lid which lasted about two months. On October 9 the edema had disappeared, the fistulas above the left eye were closed, the left frontal sinus was easily probed and there was no deformity (Fig. 9).

In January 1943 there was a small ulceration in the uppermost part of the forehead which healed without treatment. In February the left nasofrontal duct could not be probed. Therefore, on February 11, 1943, the left frontal sinus was reopened. The closure of the nasofrontal duct was found to be due to the soft tissue of the orbit bulging toward the nasofrontal duct. The mucosa of the frontal sinus and the ethmoid was edematous, but there was no pus. Thiersch flaps were implanted into the nasofrontal duct. Following that operation there were no further complaints, no metastases, no formation of fistulas and the nasofrontal duct remained patent. The patient was under observation until April 1943.

Comment. In this case a typical acute osteomyelitis was treated by conservative measures. The "drainage" of both frontal sinuses, which according to the history were performed two and three months respectively after the onset, did certainly not consist of a radical procedure.

About one year after the onset a fistula developed over the left eye, although the acute osteomyelitis had started originally on the right side. There was a continual formation of sequestra on one hand and a gradual thickening of the malar bone and of the great wings of the sphenoid on the other hand for a period of more than two and a half years. Finally, a metastasis developed in the right tibia.

As the patient insisted upon surgery, a Jansen-Ritter operation on the left frontal sinus was performed in order to avoid a marked deformity of the young girl. The operation was justified because there was a marked thickening of the floor of the sinus. Not enough time has elapsed since the operation to speak of a definite cure.

CASE 9.—D. Y., 17 years old, white, female. Seven years ago, in 1935, she became ill with delirium and high fever, one week after swimming. She was admitted to the hospital with a streptococcus

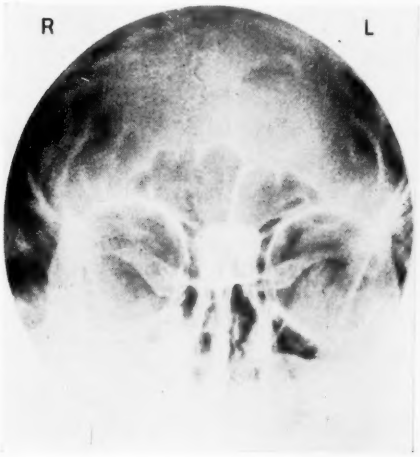


Fig. 10.—X-ray film showing cloudiness of the right maxillary sinus and sclerotic bone surrounding the left frontal sinus. Note the remnant of the implanted bone in the dorsum nasi.

meningitis. There was a marked swelling of the eyelids and of the forehead. She was treated for 14 months and during that time she lost the vision in her right eye and an abscess developed in the nasal septum which was incised. Following that operation her saddle nose, which she had acquired after an injury in her childhood, was increased and several sequestra were expelled through the nostrils. In August 1938, a bone flap from her hip was implanted into her nose to repair the saddle formation. In a short time the implanted bone was reabsorbed and there was no improvement of her saddle nose. Six months after the implantation a swelling developed in the left part of her forehead which disappeared after application of heat, but soon recurred. The swelling is still present. In August 1940 a metastasis developed in the right arm; this healed after the removal of a sequestrum. In August 1942 a metastasis developed in her right hip where the bone was removed for implantation. At present that metastasis is healed with a scar.

I saw the patient on December 23, 1942, for the first time. She was an obese girl with a very pale skin. The right pupil was dilated, but both pupils reacted to light. There was no vision in the right eye and the eye was turned to the inner canthus. There was a marked saddle nose. In the right nostril there was a hyperplastic

mucous membrane and polypi. There was a firm swelling about the size of a quarter above the left eyebrow, freely movable, but attached to the skin and tender. The skin above the swelling was a little reddened. There was a scar in the right upper arm and in the right hip. The left nostril was normal. An x-ray picture showed a marked cloudiness of both maxillary sinuses, particularly on the right side. The frontal sinuses were large and clear and the boundaries were distinct. In the area of the nasal bridge there was a quadrangular piece of bone, apparently the remnant of the implanted bone (Fig. 10). The optic foramen was normal on both sides.

On December 25 a Killian incision was made below the left eyebrow. The skin was separated but not the periosteum. In the area of the external swelling the periosteum had become replaced by connctive tissue and necrotic granulations. There was no pus and no sequestra. The granulations were removed and a defect in the periosteum the size of a cherry was exposed. In that area the external table of the frontal bone was eroded and the oozing diploe was exposed. No curretage was performed and the wound was closed. There was an uneventful recovery. Surgery on the maxillary sinus was refused by the patient.

Comment. In the presented case there was an acute osteomyelitis originating in the right maxillary sinus and leading rapidly to a streptococcus meningitis. The meningitis was cured by conservative measures, but the formation of sequestra continued in the nose and a septal abscess developed which was incised. A radical operation of the maxillary sinus was never performed.

Four years after the onset a metastasis developed on the left side of the forehead which was followed by metastases in the right arm and the right hip. A radical operation of the maxillary sinus was refused by the patient.

Of interest is the failure of the plastic repair of the saddle nose. Although the plastic operation was performed almost three years after the onset of the disease and although autogenous material was used, the greater part of the implanted bone was expelled and three years after the operation a metastasis developed at the site from which the bone was taken. It is obvious that in osteomyelitis of the skull a plastic repair never should be undertaken unless there is a definite cure of the osteomyelitis.

CASE 10.—E. U., 26 years old, white, male, was swimming in June 1931. He took a sunbath after swimming and acquired a sunburn. About eight days later he noticed a marked pain over the right eye, fever, chills and a purulent discharge from both nostrils, but there was no edema of the eyelids. A sinusitis was found and conservative treatment administered. Four days after the onset of the disease several joints on the left side of the body became swollen and tender. He was brought into a hospital where the diagnosis of pyemia was made. For three or four weeks he had fever between 104° F. and 105° F.; he was delirious and lost his hair. After nine weeks of conservative treatment he was dismissed.

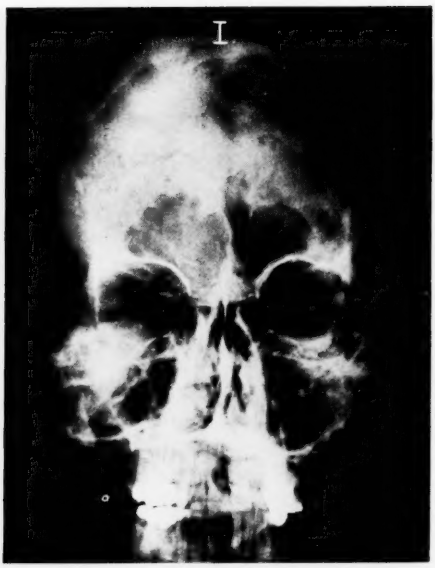
In February 1932 he noticed a swelling over the left clavicle following a slight injury at that site. There was no pain and no fever. After two to three weeks an abscess ruptured and a draining sinus developed. After three more weeks the patient himself removed a sequestrum. In April 1932 an operation was performed on the left clavicle and in the pus staphylococcus albus and staphylococcus aureus hemolyticus were found. In August 1932 there were several tender swellings over the entire skull. In September 1932 a few of these abscesses ruptured and draining sinuses developed. Further abscesses developed on the left radius and on the left tibia; both were operated upon and cured.

On October 28, 1932, there were multiple abscesses in the scalp ranging in size from a dime to a half dollar. In the center of these abscesses there seemed to be cavitations. Incisions were made directly over the draining sinuses down to the outer table of the skull. The scalp was stripped from the outer table in these areas. The bone in most instances was found intact giving no evidence whatsoever of bony involvement. However, in one abscess a small piece of sequestrum was found.

Later the patient developed an abscess on the right humerus. On December 14, 1932, incisions were made over four remaining areas of the scalp and carried down to the skull, which in all instances was smooth and sclerotic except for two areas where pinhead-sized cavities were found. These were curetted out and found to extend 2 mm. into the skull.

In April 1933 two abscesses developed on both femurs, the pus of which contained staphylococcus albus hemolyticus.

On July 25, 1935, three draining sinuses located in the right parietal, the right temporal and the right occipital parts of the skull



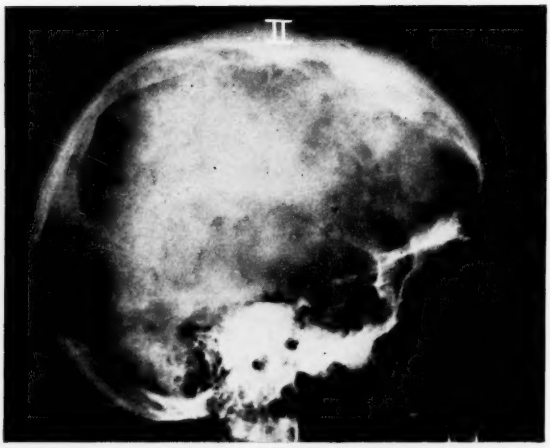


Fig. 11.—X-ray films of Case 10. Film I was taken on March 2, 1942. Note the cloudiness of the right frontal sinus and the sclerotic bone at the boundaries of the sinus.

Film II, taken on the same day, presents a thickening of the skull bones due to newly formed bone. The arrow points to a sequestrum.

were enlarged to about 6 mm. in diameter by crucial incisions made in each and granulations were curetted out.

In July 1936 an enormous abscess developed in the right tibia, the pus from which contained staphylococcus albus hemolyticus. This abscess was cured as late as November 1940. Later he noticed several abscesses in the soft tissue of the region of the pelvis.

On November 26, 1941, polypi were removed from the right nostril. At present, he notices swellings over the skull, particularly in front of the ear; there is no headache.

In 1933 he suddenly became deaf on the right side and has suffered from tinnitus ever since. The left ear is normal. An operation on the paranasal sinuses was never performed, but on January 28, 1940, a nontoxic adenoma of the thyroid was removed.

I saw the patient on January 26, 1942, for the first time and found a healthy looking, strong young man. The ear drums were retracted and in front of the right tragus there was a soft swelling the size of a hazelnut. There was a profound deafness on the right side. The nasal mucous membrane was inflamed and there was thick pus in the right middle meatus. An x-ray picture, taken on February 3, 1942 (Fig. 11), revealed a marked cloudiness of the right frontal sinus, the right ethmoid and the right maxillary sinus. The bone surrounding the frontal sinus was sclerotic but the boundaries of the sinus were distinct. The posterior wall of the frontal sinus was not thickened. In the anterior half of the skull there were cloud-like sclerotic areas where the typical structure of the diploe was missing. The bones of the vault were markedly thickened, particularly in the area of the vertex, where the diploe was entirely replaced by thickened bone, the latter bulging into the inside of the skull. There was a small sequestrum in the left parietal bone. The sella was enlarged. There were several scars and uneven spots on the skull, particularly on both sides of the sagittal suture, but there was no perforating defect. Irrigation of the right frontal and maxillary sinuses produced pus. The patient refused any further surgery and took great amounts of sulfanilamide.

Comment. In the presented case an acute osteomyelitis originating in the right frontal sinus marked the onset of the disease. Although early in the disease a pyemia became manifest, conservative treatment was administered and no operation was performed on the sinuses.

Eight months after the onset the first metastasis appeared in the region of the left clavicle; this was followed by a great number of metastases all over the body. I saw the patient more than ten years after the onset and it was amazing that, in spite of the chronic sepsis and in spite of the continual intake of sulfanilamide, the patient appeared healthy and did not complain of anything particularly.

The profound deafness on the right side, which set in suddenly two years after the onset, should be emphasized. According to the microscopic findings I[15] obtained in another case of osteomyelitis, the deafness is due to an interstitial neuritis of the cochlear nerve combined with an osteomyelitic type of otitis media which does not perforate the drum for a long period of time.

CASE 11.—A. W., 25 years old, white, male, had headache and vomiting after swimming in 1929. Three days later a swelling appeared around the left eye. On the fourth day a probatory opening of the left frontal sinus was performed, and one week later a second operation was done. In spite of these operations sequestra were expelled from the left frontal sinus for almost one year. One year after the operation the defect on the forehead was repaired by implantaton of rib cartilage and at the same time sequestra were removed from the vault.

About three years after the onset of the disease the first metastasis appeared in the right hip; this was followed by a great number of metastases which required 87 operations (including plastic procedures). Since 1934 he has suffered from a generalized amyloidosis. Six days prior to admission he noticed headache and pain in the left ear. The next day a paracentesis was done which was followed by two more.

On April 2, 1942, when I saw the patient for the first time, he was very ill. His skin had a shallow puffy appearance. There were several scars over the scalp.

There were several grooves in the bony vault but nowhere was the dura exposed. There was also no defect in the area of the supra-orbital arches. The x-ray pictures (Fig. 12) revealed normal maxillary sinuses. Both ethmoids were cloudy, the left more than the right. The right frontal sinus was of moderate size, was hazy and showed distinct boundaries. The left frontal sinus was small, cloudy and the boundaries were distinct. The supra-orbital arches showed indistinct boundaries and above the left there was a sclerotic area. In the area of the glabella the implant could be seen extending from

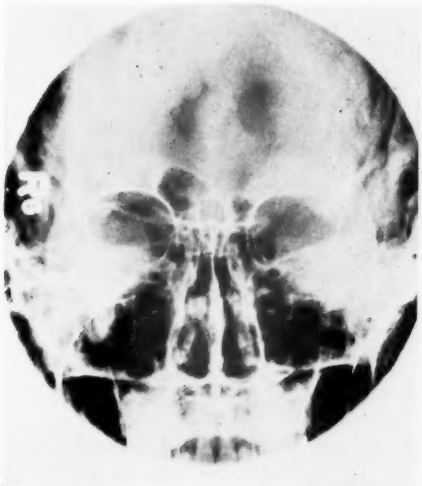


Fig. 12.—Film, taken on April 4, 1942, shows the implanted bone in the midline of the forehead; defect in the bone on both sides of the implanted bone; sclerotic bone in the frontal squama, in the left malar bone and in the lateral wall of the orbit on the left side.

the frontal sinuses toward the vertex. On both sides of the implant there were two defects of the bone with irregular margins, the defects being surrounded by a tissue without definite structure. The greater part of the vault consisted of sclerotic bone. The base of the skull was normal (Fig. 12). The left temporal bone showed a diminished pneumatization; the pneumatic cells, as far as they were present, were definitely cloudy.

The right ear was normal. On the left side there was a profuse secretion of pus which was expelled with pulsating motions. The entire planum mastoideum was edematous and tender. There was a definite sagging of the superior and posterior walls of the external canal and there were granulations in the middle ear. Accentuated whispered voice was heard for one meter on the left side. There was no spontaneous nystagmus. A large defect in the anterior part of the nasal septum caused by a submucous resection was present. In the right nostril there was pus; the rest of the mucous membrane was dry and covered with crusts as was the mucous membrane of the mouth. The tonsils had been removed. The extremities were covered with scars and the hip joints were ankylosed. There was a

marked edema of the scrotum and a marked anemia, the hemoglobin being 70% and the erythrocyte count, 3,840,000.

Although there was a definite mastoiditis, no operation was performed and the patient was put on sulfadiazine. The mastoiditis improved spontaneously and the patient was dismissed with a normal middle ear and normal hearing.

About four months later the patient developed uremia and went rapidly downhill. He expired on August 17, 1942.

The autopsy revealed amyloid degeneration of the kidneys, amyloidosis of the liver and adrenals, a focal pyelonephritis, a hemorrhagic cystitis, a marked splenomegaly with infections and softening of the spleen, cortical cysts of the kidneys, a cortical hyperplasia of the left adrenal gland, small embolic abscesses of the lungs and myocardium, a bilateral pulmonary edema, and a marginal atelectasis of the right lower lobe. No autopsy of the skull and the brain was performed.

Comment. The presented case resembles the preceding case. The disease set in with a typical acute osteomyelitis originating in the left frontal sinus. Minor operations were performed on the sinus which were followed by a continual formation of sequestra. An operation on the frontal squama was omitted.

One year after the onset the frontal sinus was considered cured and a plastic repair was performed which was successful. However, the osteomyelitis was actually far from being cured. It spread slowly and was active, serving as the origin of a sepsis which produced a great number of metastases all over the body and required 87 operations. The sepsis finally led to a general amyloidosis and to the death of the patient 13 years after the onset of the disease.

In the course of his long illness the patient presented a definite mastoiditis with all the classical symptoms. I refused to perform an operation for two reasons: First, the patient was a poor surgical risk; second, I knew from experience that in acute osteomyelitis of the skull a simple mastoid operation might be followed by a diffuse labyrinthitis and meningitis even if the patient were in a better general condition than this patient actually was. Although the presented case did not have an acute osteomyelitis, but a secondary chronic osteomyelitis, it was assumed that the same danger was imminent as in a case of acute osteomyelitis. Thus, conservative treatment, including heat and the administration of sulfadiazine, was

chosen as the proper procedure although there was an unquestionable indication for surgery. To our surprise the conservative treatment accomplished a better effect than surgery ever would have done.

SUMMARY

Etiology. The etiology was the same in all four presented cases: an acute infection of the paranasal sinuses. In three instances the frontal and in one instance the maxillary sinus was primarily involved.

So far as bacteriological data are available hemolytic streptococci and staphylococci were found as is the case of acute osteomyelitis.

Clinical Course. Chronic osteomyelitis of the secondary type is chiefly characterized by its acute onset, by a slow but definite tendency of spreading within the bone and by its marked tendency of spreading within the blood, viz., by causing a chronic septicemia.

In all presented instances the disease set in with the typical symptoms of an acute osteomyelitis. However, that onset was not followed by a constant progress toward the vault of the skull and a progressive destruction of bone, nor by a self-limited course leading to the formation of one single sequestrum without further symptoms of progress, nor by a brain abscess or a fulminating meningitis. Only in Case 9 was there a streptococcus meningitis originating in an infected maxillary sinus, but the meningitis was cured and then the chronic osteomyelitis made its appearance.

In the presented cases the acute osteomyelitis gradually turned into a chronic osteomyelitis which was definitely progressive. However, the progress was extremely slow, extending over a period of years, and did not consist primarily of a destruction of bone; rather it consisted of the formation of new bone leading to a thickening and sclerosis of the vault, of the malar bone and of the wings of the sphenoid, and, to a lesser degree, to the formation of sequestra probably due to an obliteration of blood vessels. There were always multiple sequestra (in contradistinction to the self-limited type of acute osteomyelitis) which frequently contained parts of the lamina externa and of the diploe of the bones of the skull but which did not produce penetrating defects of the bones of the vault.

The most important feature was the chronic septicemia, characterized by the appearance of metastases. There were no marked changes of the blood or of the spleen. So far as the pathology of

the metastases is concerned one must recall that in the Cases 8, 10 and 11 there were numerous defects of the skull close to the midline. That finding suggests that the metastases were perhaps not due to the infection of the bone per se, but rather to a thrombophlebitis of the superior longitudinal sinus subsequent to the osteomyelitis. Unfortunately, there was no material available to prove that hypothesis. However, the high fever in Case 8 and the definite pyemia in Case 10 at the onset of the disease certainly are in favor of it.

In the presented cases it took three years on the average until the first metastasis. Only in Case 10 did the first metastasis appear a little more than one half a year after the onset. However, in that instance the appearance of the first metastasis in the clavicle was preceded by a slight injury on that site, which certainly favored the development of the metastasis. In all instances the first metastasis was soon followed by other metastases and Case 11 presents the tragic outcome of these cases leading to a general amyloidosis.

Pathology and Roentgenology. Although there was no material available for microscopic examinations, the study of the x-ray films seems to indicate that the pathology is very similiar to that of chronic osteomyelitis of the primary type. The infection in both types produces osteoclasis and osteogenesis, the latter being predominant. Due to these changes, thickening and sclerosis is caused on one hand; sequestra, on the other hand. However, there are some points of difference between chronic osteomyelitis of primary and secondary type. While in the former the sclerosis is to be found in the boundaries of the frontal sinus and spreads extremely slowly into the surrounding parts, in the latter the frontal sinus may regain its normal appearance while the sclerosis and the sequestra are to be found in the distant parts of the skull, as in the vault or in the malar bone or in the wings of the sphenoid. Therefore, in instances in which an x-ray film is taken several years after the onset, the boundaries of the frontal sinus may appear distinct, although the disease undoubtedly originated in the frontal sinus. That finding was obtained in Cases 10 and 11; in Case 8 the boundaries of the sinus were indistinct as only three years had elapsed since the onset of the disease. In that instance the infection within the walls of the frontal sinus was still active, as was proved by the draining fistula in the eyebrows.

Treatment. The treatment of these cases is extremely unsatisfactory. There are a chronic septicemia, a widespread osteomyelitis and there are, as a rule, metastases which may eventually also serve as

the origin of septicemia. It is obvious that under these circumstances surgery cannot accomplish very much. An exception is Case 8, as in that instance there were draining fistulas in the eyebrow which absolutely required surgery. The operation was performed after the technic of Jansen-Ritter in order to avoid a deformity, the operator bearing in mind that a definite cure could not be accomplished even by the most radical procedure.

The results of conservative treatment are not exactly known. I did not employ vaccines. Concerning the sulfonamides I had two interesting experiences: In Case 11 there was a mastoiditis which was so far progressed that a spontaneous cure could not be expected, particularly not in a patient who suffered from a chronic septicemia. There was a profuse discharge from the ear, a sagging of the superior and posterior walls of the external canal and an edema of the entire planum mastoideum. Even one who is sceptically minded must admit that in a case of that type the cure was due to the administration of sulfadiazine. The second experience concerned Case 10, in which great amounts of sulfanilamide were taken. Whether or not the development of new metastases was inhibited by the drug cannot be definitely stated, as even without sulfanilamide years may elapse between the appearance of two metastases. Without drawing definite conclusions, I believe that occasionally metastases can be successfully treated with sulfonamides.

For the chronic septicemia per se nothing can be done at present other than the administration of vitamins, tonics and eventually iron. Perhaps further studies will improve the treatment and the outlook of the disease.

At present, the best treatment consists of avoiding the change of the acute osteomyelitis into the chronic form. That can be accomplished only by radical treatment of acute osteomyelitis as advocated by Schilling,[16] McKenzie,[17, 18] Mosher[19, 20] and others. I certainly do not want to say that in all cases of acute osteomyelitis extensive surgery is required; however, one has to keep in mind that in acute osteomyelitis a subsidence of symptoms by no means always indicates a definite cure. In the presented instances no surgery or insufficient surgery was performed when they ran through the acute stage. It seems justifiable to assume that probably the chronic osteomyelitis could have been avoided if, in the acute stage, radical procedures had been employed.

307 N. Michigan Blvd.

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Clinical Notes

LXVIII

BACTEROIDES MENINGITIS—REPORT OF A CASE WITH RECOVERY

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In the 40 years between 1898 and 1939 11 cases of meningitis or brain abscess due to anaerobic, gram-negative, non-spore-bearing bacilli (Bacteroides) were described. All were fatal and all, with one exception, arose from chronic otitis media.

In the two years between 1941 and 1942 four patients with Bacteroides meningitis, two of whom had brain abscess, were seen in this hospital. The infection in all of these cases arose from chronic otitis media. Three recovered. These cases have been described previously, together with a survey of the literature and a description of bacteriological findings and methods.[1]

The present paper reports a fifth case of Bacteroides meningitis of otitic origin with recovery.

A general review of all types of Bacteroides infections based on the observation of 20 cases, including septicemia, peritonitis, liver, kidney, joint and skin abscesses, chronic cervicitis and prostatitis is given in another place.[2]

REPORT OF A CASE

A 13-year-old girl was admitted to the Massachusetts Eye and Ear Infirmary on March 9, 1943, because of left chronic suppurative otitis media.

This is publication No. 75 of the Robert W. Lovett Memorial for the study of crippling disease—Havard Medical School.

From the Massachusetts Eye and Ear Infirmary, Department of Otolaryngology, and The Massachusetts General Hospital, Department of Pathology and Bacteriology.

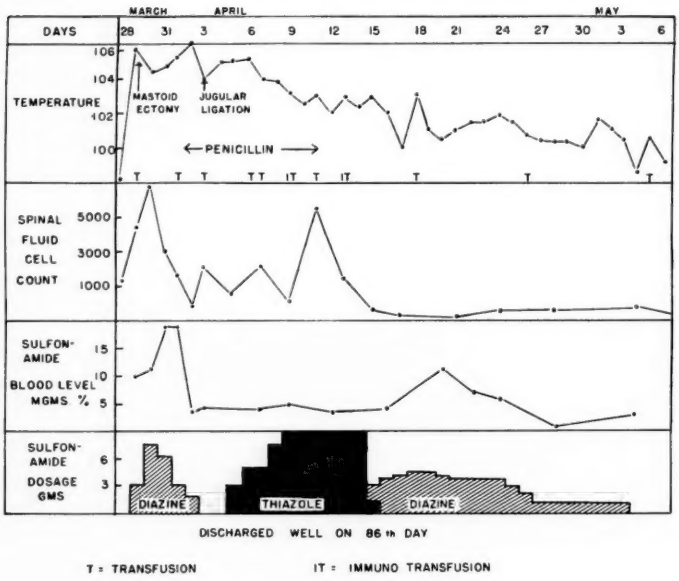

CHART I

The past history was essentially negative except for the ear infection. A simple left mastoidectomy had been done when the patient was two years of age and two subsequent revisions had been made before the age of five. A purulent discharge from the ear had been noted for 14 months before admision.

On admission, the physical examination was essentially negative except for the observation of a foul, purulent discharge from the left ear and a small polyp in the left ear canal. Only remnants of the drum remained. Aerobic cultures of pus from the ear yielded Staphylococcus aureus and Bacillus proteus. Anaerobic cultures were not made.

Operation was postponed because of a sore throat; cultures of secretions taken from the throat yielded beta hemolytic Streptococci.

A left postaural abscess developed, which was incised, and foul smelling green pus evacuated. Aerobic and anaerobic cultures of this pus yielded no growth.

On March 19 the polyp was removed from the left ear canal.

On March 26 the patient began to complain of frontal headache and two days later the temperature suddenly rose to 106° F. and the neck became stiff. Lumbar puncture yielded fluid with a ground glass appearance and a cell count of 1,080 white blood cells per cu. mm., 70% polymorphonuclears. No organisms were seen in smears and cultures were sterile. On five subsequent occasions, however, Bacteroides were recovered in pure culture from the spinal fluid.

A radical mastoidectomy was done with exposure of the tegmental dura and the lateral sinus, which appeared grossly normal. No frank pus was found. A few granulations were removed from the mastoid antrum. Blood cultures yielded group A beta hemolytic Streptococci on March 31 and alpha hemolytic Streptococci on April 3, but were subsequently sterile.

On April 3 the mastoid was again explored and the lateral sinus was found to bleed readily from below but sluggishly from above. The left internal jugular vein was thereupon ligated.

On April 16 the patient complained of pain in the left hip, which could be elicited by movement of the leg. Metastatic abscess of the hip joint was suspected, but the pain disappeared within two to three days.

The fever continued for five weeks. From April 17 gradual improvement took place and the patient was discharged as well on June 21, 1943, 86 days after the onset of the meningitis. A left abducens nerve paralysis was the only residuum of her illness.

Treatment.—Lumbar punctures were done daily during the first week, every other day during the next three weeks. Eleven transfusions were given, two of which were from a donor whose blood contained opsonins for the streptococci cultivated from the patient's blood. Intravenous fluids were given when necessary to maintain adequate fluid intake. Sulfonamides and penicillin were used as outlined in Chart 1. The dosage of penicillin was 5000 units intramuscularly every two hours. Sulfathiazole was substituted for sulfadiazine because of the development of leucopenia, which however did not recur on subsequent readministration of sulfadiazine.

Laboratory Data.—The red blood cell count ranged from 3,800,000 to 4,700,000 cells per cu. mm. The white blood cell count ranged from 24,000 to 5,500 cells per cu. mm., 96 to 66% polymorphonuclears. The urine was not remarkable. The spinal fluid

SPECIAL FLUID DATA

CHART 2

Date	Pressure mm. H20 Initial	Final	Cells per cu. mm.	% Pmn.	% Lymp.	Sugar mg. %	Protein mg. %	Chloride mg. %	Culture	Time at which culture grew out.
March 28	270	200	1,080	70	30	22	201			
29	500	200	4,400	87	13	20	240		—	
30	300	115	7,264	93	7	20	240		+	Two days.
31			2,889	93	7	25	87	672	+	Six days.
April 1			1,575	89	11	24	78	642		
2	150	90	483	74	26	52	94	658	+	Three days.
3	320	120	1,791	88	12	29	74			
5	250	110	780	94	6	28	81	644	+	Four days.
7	250	90	1,899	94	6	16	117		+	Seven days.
9	280	130	543	88	12	48	93		—	
11	200	100	5,400			35	102		—	
13			1,161	90	10	25	106			
15	230		300	90	10	20	141	635		
17	175	90	250	66	34	40	100			
21	90		126	46	54	34	126	677	—	
24	86	40	366			27	106		—	
28	50		458	16	84	31	129	657		
May 4	130	80	472	18	82	27	294	687	—	
10			314	1	99	33	200	713	—	
17	140	120	382	5	95	32	147		—	
24	100	92	177	1	99	37	102		—	
June 8	130	120	85	4	81	39	60		—	

findings are presented in tabular form (Chart 2). Gram-negative bacilli were seen in direct smears of spinal fluid on March 30 but not thereafter. The sulfadiazine concentration in the spinal fluid on April 1 was 7.7 mg. per 100 cc. On April 2 it was 10.2 mg. per 100 cc.

Bacteriology.—Spinal fluid was cultivated on blood agar plates, neopeptone infusion broth, chocolate agar slants and Brewer's thioglycollate broth,[3] the latter being an anaerobic medium. Growth was obtained only in the anaerobic medium after periods of incubation stated in the table. Diffuse turbidity with production of a small amount of gas and a foul odor occurred. The organisms appeared as gram-negative bacilli in long, tangled chains composed of 10 to 100 individuals. Growth was more abundant in media enriched with ascitic fluid. The chain formation was not prominent in subcultures, the bacilli appearing singly or in pairs.

After 18 hours' incubation, the organisms were predominantly regular bacilli (2 to 3 microns in length), many exhibiting fusiform swellings. After 48 hours many large round bodies (3 to 5 microns in diameter) were seen. The participation of such large bodies in a type of bacterial reproduction distinct from simple fission is described elsewhere.[4,5] Colonies on blood agar plates after 48 hours' anaerobic incubation were white, nonhemolytic and very small (0.1 mm. in diameter). The organisms were strictly anaerobic. They were killed at a temperature of 60° C. for 20 minutes. Neither spores, capsules nor motility were observed. This strain was classified in the Bacteroides funduliformis group.[1, 2]

DISCUSSION

The present case brings to five the number of cases of this type of meningitis seen at this hospital within a period of three years, only 11 cases having been reported in the preceding 40 years. It would therefore appear that Bacteroides meningitis is not uncommon but is simply not recognized, probably because of failure to make repeated anaerobic cultures in cases of otitic meningitis which yield no growth by ordinary aerobic methods.

A general discussion of the symptomatology, the pathology and the bacteriology of Bacteroides meningitis and brain abscess has been reported in a preceding paper.[1]

Bacteroides meningitis resembles clinically other meningitides due to pyogenic organisms, and the cytological and chemical findings in the spinal fluid are similar. As illustrated by the present case,

the spinal fluid shows an early decrease in sugar and increase in protein (Chart 2). The beginning of clinical improvement is accompanied by a marked decrease in polymorphonuclear cells and an increase in the percentage of lymphocytes. The occurrence of pain in the hip in this patient and of frank polyarthritis in one patient in our previous series recalls the common occurrence of metastatic joint involvement in Bacteroides septicemia.[2]

The invariably fatal outcome of earlier cases and the recovery of four of the five patients seen in this hospital is probably due in large part to modern supportive therapy, including transfusions and attention to fluid balance, and repeated lumbar punctures. The effectiveness of sulfonamide therapy is extremely difficult to evaluate. In the present case, the spinal fluid cell count fell sharply after a few days of sulfadiazine therapy, but there was no dramatic clinical improvement as is seen in meningococcus meningitis where sulfonamides are of proven value. The problem was complicated by the cultivation of streptococci from the blood. Sulfonamides, penicillin and immune transfusions probably aided in combatting the streptococcus infection. Some indication that sulfadiazine may be of value in combatting Bacteroides meningitis was gained in the previously cited series, in which one patient with three separate episodes of meningitis responded promptly on each occasion to the administration of sulfadiazine.

CONCLUSION

A case of Bacteroides meningitis with recovery is presented. The infection in this case, as in almost all previously reported cases, arose from chronic otitis media. Five such cases have recently been seen in this hospital, with four recoveries. The importance of search for Bacteroides by anaerobic cultural methods in meningitis of otitic origin is stressed.

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243 CHARLES STREET.

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LXIX

FATAL CASE OF ACUTE THROMBOCYTOPENIC PURPURA WITH SUBMUCOSAL HEMORRHAGE OF THE LARYNX AS ITS MOST PROMINENT FEATURE

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In blood dyscrasias characterized by a hemorrhagic tendency, such as purpura or leukemia, laryngeal involvement is relatively uncommon. Should intramural hemorrhage of the larynx occur, it is usually but a casual incident in the course of the generalized disease. It is, therefore, of interest to record the following case of acute thrombocytopenic purpura in which the most prominent clinical feature was laryngeal obstruction due to hemorrhage.

REPORT OF A CASE

A white soldier, aged 20, was admitted to the 210th General Hospital on December 18, 1942, at 10:15 A. M. Because of almost complete aphonia, he was unable to give a history except to indicate that hoarseness and dyspnea had appeared earlier that morning. Later it was learned that on the night of December 17, the patient had told a friend that he was getting a cold. At 7:30 A. M. the next day he reported for duty and was apparently well. At 8:00 A. M. he took quinine sulphate gr. 5 and went to bed. At 9:00 A. M. he felt feverish and became hoarse. At 9:30 A. M. he was found to have marked stridor by his medical officer and was immediately transferred to this hospital.

On admission, the patient appeared desperately ill. His temperature was 103.6° F.; his pulse 130. A loud inspiratory and expiratory stridor was audible at a distance. Respirations were labored, all accessory muscles being used. The patient assumed a supine position

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with the neck hyperextended. He indicated by motion that he had severe pain in the anterior part of the neck and over the midsternum.

There was slight pallor of the skin and moderate cyanosis of the mucous membranes. The skin was clear. The chest appeared hyperinflated. Numerous coarse rales could be heard throughout both lungs. No further examination was possible at this time.

The ear, nose and throat examination revealed the following findings: There was some bright blood on the posterior pharyngeal wall. Indirect laryngoscopy revealed: normal appearing epiglottis, false cords, pyriform sinuses and arytenoids. A small amount of fresh blood was seen in the hypopharynx. The superior surface of the true cords appeared rather dull but smooth. Along the medial surface of almost the entire length of both true cords fairly large, dark bluish-red hemorrhagic masses were visualized. The cords themselves were fixed but the arytenoids tended to move on inspiration and expiration. Only a narrow slit remained as an airway. The impression was, "laryngeal obstruction due to hemorrhagic masses in the vocal cords, the primary cause of which is undetermined; blood dyscrasia must be considered."

Conservative treatment consisting of shrinkage, steam inhalations, oxygen, and expectorants was outlined and begun. About 15 minutes after the completion of the examination, the patient had a slight hemoptysis, then became asphyxiated and semistuporous. Artificial respiration and oxygen were administered and the patient was taken to the operating room immediately.

Without anesthesia, an 8 mm. bronchoscope was introduced. An opening in the trachea at the level of the third and fourth rings was then made and a No. 5 tracheal cannula inserted. Both upon insertion of the bronchoscope and upon opening the treachea, a good deal of blood was found in the lumen. Following tracheotomy, the patient breathed freely but his color did not improve. Hemorrhage from the trachea and the lung continued. Saline and glucose solution and blood plasma were administered intravenously, but the patient died in the operating room three hours after admission.

A blood count taken previously was reported as follows: Hemoglobin 85 per cent, red blood cell count 4,350,000, white blood cell count 6,200 and the differential count: premyelocytes 6 per cent, myelocytes 4 per cent, polymorphonuclear leukocytes 51 per cent, eosinophiles 6 per cent, basophiles 2 per cent, lymphocytes 16 per cent and monocytes 15 per cent. No platelets could be

found. The blood Wassermann test was negative. Postmortem blood showed no clot retraction after 24 hours.

Necropsy revealed the following positive findings: Ecchymotic areas on various parts of the surface of the body; epicardial, myocardial, subendocardial, subdural, subarachnoid and subconjunctival hemorrhages; subserosal hemorrhage of the intestine; hemorrhage into the stomach; early hemorrhagic necrosis of the ileum. Gross and microscopic examinations of the liver and the spleen revealed no abnormalities.

The findings in the respiratory tract are given in detail: The mucosa of the posterior portion of the tongue in the area of, and behind the circumvallate papilla, and the mucosa of the oropharynx, epiglottis and aryepiglottic folds were soft, pink and wrinkled, strongly suggesting the presence of antemortem edema. Numerous petechiae and areas of ecchymosis were present beneath the mucosa of these areas. No inflammatory reaction and no exudate were seen. Beneath the mucosa of the vocal cords on both sides, there was diffuse extensive hemorrhage, but no rupture of the mucosa. The mucosa of the entire larynx was reddish-blue, apparently discolored by submucosal hemorrhage and by reddish-black blood which filled the lumen. The lungs were extremely heavy; on sectioning, the parenchyma was found to be almost one solid mass of reddish-black blood. Most of the mucosa of the major bronchi was extremely congested. The lumina of the bronchi were filled with clotted blood.

Microscopic examination of the base of the tongue, the epiglottis and the trachea showed extreme submucosal hemorrhage which was diffuse and confluent. No leukocytic reaction was seen. The hemorrhage did not extend into the deep tissues.

DISCUSSION

The necropsy diagnosis was acute thombrocytopenic purpura. The clinical and laboratory findings are adequately explained on this basis. The etiology, as in most cases, is a matter of speculation only. Cases are recorded in which quinine sensitivity resulted in purpura. The patient had taken quinine on numerous previous occasions; his fellow soldiers said that it gave him "shivering attacks." Whether the symptoms exhibited by the patient prior to taking the quinine on the morning of the illness were those of the fatal condition, or whether they were those of respiratory infection and the purpura was caused by sensitivity to the quinine cannot be determined.

The initial examination did not reveal the edema and submucosal hemorrhages of the oropharynx and the epiglottis which were found at necropsy. This discrepancy may be explained either by the rapid progression of the disease between the time of examination and death or by trauma resulting from the passage of the bronchoscope.

Acute thrombocytopenic purpura is characterized by a very high mortality. Treatment consists of supportive measures, particularly frequent blood transfusions. Surgical procedures of any kind must not be performed, at least until the bleeding tendency has been overcome. The circumstances in this case were antagonistic to adherence to such a program. During the three-hour period from admission to death, the necessity of urgent treatment of the laryngeal condition prevented adequate physical examination or laboratory study, so that the exact nature of the basic condition was not recognized. Moreover, even if this had been known, it would not have been possible to defer surgical therapy. From the necropsy findings, it appears likely that the fatal outcome would have ensued, whether or not the operative procedure had been performed. However, what little chance for recovery might have existed was probably destroyed by the mishap of having a complication requiring immediate operative intervention in a disease in which surgery is contraindicated.

SUMMARY

A fatal case of acute thrombocytopenic purpura is reported. The initial and most prominent symptoms were due to severe laryngeal obstruction caused by hemorrhage into the vocal cords.

210TH GENERAL HOSPITAL, A. P. O. 837.

LXX

OSTEOMYELITIS WITH FISTULA, ORBITAL CELLULITIS AND ABSCESS, AND DIPLOPIA COMPLICATING PANSINUSITIS

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This case is reported because it presents several complications of nasal sinus infection at one time, with recovery.

REPORT OF A CASE

A patient, F. C., aged 36, was transferred to the Veterans Administration Facility from a U. S. Army hospital on May 23, 1943.

The U. S. Army records revealed that for the past four years the patient had intermittent, dull, left frontal headaches for which he had received symptomatic treatment. On July 2, 1942, the patient passed the physical examination given by the U. S. Army.

On January 31, 1943, the patient developed an "acute head cold." This was followed one week later by severe pain over the left eye. Two days later, swelling and redness of the left upper lid was present. This swelling continued for several weeks and gradually fluctuation developed. On April 13, 1943, a horizontal incision about ¾ inch long was made into the localized swelling and pus escaped. The incision did not heal, but a fistula developed which continued to drain.

The personal and the family history revealed that the patient was a general worker in a canning factory prior to enlistment in the U. S. Army on July 2, 1942. He was honorably discharged from the Army on May 23, 1943. His mother, aged 72, is in good health. His father died at the age of 89 from cancer. One brother has pulmonary tuberculosis. The patient had all childhood diseases. He had epileptic seizures at the age of three but none since. In an auto-

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mobile accident in 1929, injury to the lower jaw and lower lip was sustained. Otherwise the history contained no relevant data.

Examination at the U. S. Army hospital showed a large amount of thick yellow pus beneath the left middle turbinate and polypoid tissue in this same area. There was tenderness over the left frontal bone. The left maxillary and frontal sinuses were cloudy on transillumination. The left upper lid was swollen and discolored.

X-ray examination of the sinuses on February 10, 1943, revealed a pansinusitis on the left side. Radiographs taken on March 30, 1943, and April 12, 1943, showed a progression of the pathology with necrosis of the floor of the left frontal sinus. X-ray films taken on April 19, 1943, April 21, 1943, and May 12, 1943, showed further progression of the disease and revealed a fistula when radiopaque material was injected through the incision of the eyelid.

X-ray films of the chest taken on March 9, 1943, April 3, 1943, and April 25, 1943, were negative.

At the Army hospital the patient received intensive sulfonamide therapy.

On admission to this hospital on May 23, 1943, examination revealed the following: a well-developed, well-nourished white male, 71 inches in height and 135 pounds in weight.

Eyes. The vision in right eye is 20/20; in the left 20/20. Diplopia is present and has been for the past two months. The left eyeball is displaced downward. The right lids are normal. A sanguineous, purulent discharge exudes from the center of the left upper lid, where there is a gaping, horizontal incision; surrounding this area there is redness and induration. The right conjunctiva is normal; on the left there is chemosis of the bulbar conjunctiva, and the palpebral conjunctiva is slightly injected. The media are clear. The discs of the fundi are normal in color; the margins are distinct. The retina shows no hemorrhages, and no exudate.

Nose. The right side is normal. On the left side a thick, creamy, purulent secretion is present in the olfactory fissure and in the middle meatus. The mucosa of the middle and inferior turbinates is congested.

Sinuses. By transillumination the left frontal and left antrum are dark.

Ears. The findings in the ears are normal.

Mouth. The patient is edentulous.

Throat. The findings are normal.

Glands. There is no lymphadenopathy.

Neuropsychiatric. The deep and the superficial reflexes are present and physiologically active. No abnormal behavior is noted. There are no sensory changes.

The remainder of the examination reveals normal findings.

The temperature is 98.6° F.; pulse 82; respiration 20.

Laboratory Reports. The blood examination is as follows: red blood cells, 3,460,000; white blood cells, 10,200; polymorphonuclears, 88; lymphocytes, 16; monocytes, 2; hemoglobin, 14 gm.; coagulation time, 3 minutes; bleeding time, 1½ minutes. The precipitation test for syphilis is negative. The urine examination is as follows: color, amber; reaction, acid; specific gravity, 1.022; albumin, 0; sugar, 0; white blood cells, 0; red blood cells, 0; casts, 0. Smear from the left orbit shows "gram-negative diplococci intracellular, morphologically similar to catarrhalis." Culture of the nasal secretions reveals "staphylococcus." Radiographs of the nasal sinuses show marked irregularity of the margins of the left frontal sinus with some clouding and a loss of substance along the left orbital ridge. There is marked opacification of the left antrum and the left ethmoid cells. X-ray impression: Pansinusitis, left; osteomyelitis, roof of orbit.

Clinical Diagnoses. Pansinusitis, suppurative, chronic, left, with osteomyelitis of the orbital plate of left frontal bone, fistula, orbital abscess and cellulitis, and diplopia.

Since conservative management for several months, including sulfonamide therapy, did not stop the progress of the disease, and since there were present dangerous complications, it was thought advisable to institute radical surgery. The presence of necrosis of the floor of the frontal sinus made it imperative to direct our attention first to the frontal sinus. A modified Killian operation was decided upon for the following reasons: First, it was necessary to remove the necrotic tissue from the floor of the frontal sinus; second, extensive removal of the ethmoid cells was indicated; third, the frontal sinus was widespread, as shown by radiographs.

Accordingly, on May 28, 1943, under local anesthesia obtained by using four per cent cocaine hydrochloride topically and two per cent novocain solution by block and infiltration methods, the author performed a radical frontal sinus operation. A bridge of bone with

the attached periosteum just above the orbital margin, about 12 mm. in width, was left undisturbed to prevent subsequent sinking of the soft tissue and consequent deformity. Great care was taken not to disturb the periosteum which covers this bridge of bone, for should the periosteum be elevated or removed, the underlying bone would die and a deformity would certainly occur. Above this strip of bone, after the soft tissues and the periosteum were retracted, the anterior wall of the sinus was removed. Thick pus was present in the sinus and when this was suctioned out, the mucous membrane appeared thickened with polypoid degeneration and angry granulations in several areas. All diseased mucosa was removed; a partial septum was broken and removed. The periorbita was then retracted, care being taken not to injure the pulley of the superior oblique muscle. The osseous wall between the orbit and the sinus, including all of the necrotic bone, was removed. The ethmoid cells, which contained granulation tissue and pus, were removed, the operator being certain that all cells were exenterated so that no suppurating cells would be left behind to infect the entire wound. The ethmoid bulla wall was then removed so that a large communication was made between the frontal sinus, the orbit, and the nose. A light pack of five per cent sulfathiazole ointment gauze was inserted into the cavity above the orbital rim and brought out through the nose. The orbital tissues were replaced; the pulley of the superior oblique muscle was placed in the site of the little pit. Should the pulley have been displaced, double vision would have been certain to follow.

Pathological examination of a specimen of the tissues removed revealed "multiple small snips of tissue, some bony hard. Microsection reveals osseous and osteoid tissue with many cells, for the most part mononuclear. There are a few polynuclears. There is much blood clot. Diagnosis: Osteomyelitis, chronic."

Postoperatively the temperature rose to 100.5° F. in the first 24 hours, following which the temperature remained essentially normal. Sulfathiazole in doses of 60 grains daily for four days preoperatively and seven days postoperatively was given for prophylactic purposes. On May 30, 1943, the diplopia disappeared. The external wound and the fistula healed in several days. The intranasal discharge diminished in quantity. The orbital cellulitis subsided. The patient's general condition improved greatly. Radiographs taken June 10, 1943, revealed a horizontal area of comparative haziness in the lower portion of the vertical plate of the left frontal bone (this corresponds with the bridge of bone left), with an area of increased radiolucency immediately above in the area of the frontal sinus. There

was a more definitely defined defect in the orbital plate of the left frontal sinus. The left maxillary sinus showed increased density with thickening of the mucous membrane lining.

We know that the passage connecting the frontal sinus with the nose can empty into the middle meatus directly, or it can join the hiatus semilunaris at its anterior end and then empty into the maxillary sinus through the ostium maxillare. In the latter situation the antrum becomes a cesspool to catch the drainage from both the frontal sinus and the anterior ethmoidal cells. Since the mucous membrane was thickened and since purulent material was present in the antrum for at least several months, it was felt that pathological changes had taken place in the antrum which required radical surgery.

On June 14, 1943, an antral irrigation on the left side produced milky and pinkish washings with shreds of purulent material.

On June 15, 1943, sulfathiazole in doses of 45 grains daily was started as a pre-operative prophylactic measure and was continued postoperatively for 48 hours.

On June 17, 1943, the author performed a radical antrum operation under local anesthesia obtained by using four per cent cocaine hydrochloride solution topically and two per cent novocain solution by block and infiltration methods. The Caldwell-Luc method was chosen, for the reasons that it is a very satisfactory method and that in this case the patient was edentulous and injury to the anterior and middle alveolar nerves which innervate the canine and incisor teeth was not a consideration. When the anterior wall of the antrum was removed, pus under pressure escaped. The lining mucous membrane was thickened, polypoid, and in places hemorrhagic. After the diseased tissue was removed and a naso-antral window was made, a five per cent sulfathiazole ointment pack was inserted into the antrum and brought out through the naso-antral window into the nose.

Postoperatively there was very little reaction. The temperature did not rise. The swelling of the left cheek subsided in five days. There was a moderate amount of nasal discharge which gradually diminished.

The pathological examination of a specimen of the tissue removed from the antrum showed "an extremely edematous connective tissue stroma in which the connective tissue fibrils are widely separated. There is a typical columnar globe-cell epithelial cover-

ing. There is a dilatation of the capillaries in the stroma. There is much cellular infiltration, for the most part consisting of plasma cells. There are very few polynuclears. There is papillary and cystic formation. Diagnosis: Chronic sinusitis (polypoid and cystic)."

A culture taken from the pus at the time of operation showed "gram-positive cocci in short chains, gram-positive diplococci, and gram-positive cocci resembling staphylococcus predominating."

In addition to the surgery and sulfonamide therapy, the patient received treatment with one per cent ephedrine hydrochloride intranasally, ferrous sulphate and reticulogen, sedation, and supportive care.

Additional blood counts made were as follows: May 31, 1943, red blood cells, 4,240,000; white blood cells, 8,700; hemoglobin. 14.6 gm.; polymorphonuclears, 70; lymphocytes, 20; monocytes, 6; eosinophiles, 4. June 15, 1943, red blood cells, 3,930,000; white blood cells, 10,500; hemoglobin, 14 gm.; polymorphonuclears, 56; lymphocytes, 40; monocytes, 2; eosinophiles, 2.

On July 7, 1943, the patient was discharged from the hospital. At this time the external wound was well healed, and was very slightly noticeable only on the medial side of the orbit. No deformity was present. The fistula had completely healed, leaving a small external scar on the left upper lid. The gingivobuccal wound was well healed. There was a large patent naso-antral window but no purulent secretion in the left nasal fossa. No diplopia was present. The external as well as the internal structures of the left eye appeared normal. The general condition of the patient subjectively had greatly improved.

CONCLUSIONS

A case of pansinusitis complicated by osteomyelitis of the orbital plate of the frontal bone, fistula formation, orbital cellulitis and abscess, and diplopia, is presented. Recovery was brought about by surgical procedures when adequate medical care failed.

Sulfathiazole was used as a prophylactic, pre-operatively and postoperatively.

Radical nasal sinus surgery was carried out with success and without pain under local anesthesia.

VETERANS ADMINISTRATION.

Society Proceedings

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Meeting of Monday, April 5, 1943

THE PRESIDENT, DR. G. HENRY MUNDT, IN THE CHAIR

Anatomy of the Tracheobronchial Tree—Study of Twenty Pairs of Lungs; Preparation of Lungs for Demonstration

E. W. HAGENS, M.D.

(Abstract)

An examination of textbooks and the literature shows that there have been a number of valuable studies made on the anatomy of the lung. These include the usual dissections and special cast work of the lung, such as reported so beautifully in 1940 by De Pablo. However, when the bronchi are considered more strictly from the bronchoscopic viewpoint there is much less to be found. Several years ago Huizinga and Behr made such a report on an investigation of 125 pairs of lungs. They describe the usual bronchial tree and entitle their paper "Systematic Bronchoscopy." While the study of the anatomy of the lung from the various points of view is necessary and most valuable to the endoscopist, nevertheless no one but those doing such work views the bronchi in the endoscopic manner. In recent years endoscopy has become more and more useful to the internist, the chest surgeon and the pediatrician. As a result, the endoscopist has of necessity been forced to extend his knowledge of the chest structures.

While it is possible actually to see only down to a certain point in the bronchi, it is evident that to know the usual bronchial divisions and their general directions may be of great help in localizing pathologic conditions. It was with these thoughts in mind that 20 pairs of cadaver lungs were dissected and measurements taken. It is evident that measurements of the lungs from cadavers cannot be considered as accurate as those from the living; however, they repre-

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sent an approximate measurement and give an idea as to the relative dimensions of the various bronchi. Unfortunately, the sex and race of those from whom the lungs were taken could not be obtained in enough instances to be of value.

The following is a résumé of the dissections:

The trachea averaged 11 to 12 cm. in length, and 20 mm. wide by 17 mm. vertically. The right main bronchus comes off at about a 25 degree angle, the left at about 45 degrees. The right bronchus is about 2.5 cm. in length, although one specimen was 4.5 cm.; it is 14.5 mm. horizontally and 12 mm. vertically. The left bronchus is about 5 cm. in length and 14 mm. horizontally by 10 mm. vertically.

The diameter of the orifice of the right upper lobe bronchus is about 9 mm.; that of the middle lobe 3x7 mm., while the lower lobe is about 7x8 mm. On the left side the upper lobe orifice is 8x9 mm., while the lower lobe bronchus measures about 6x9 mm.

In five instances there were only two lobes on the right side, the upper and middle lobes being represented by a single upper lobe. In one specimen four lobes were found, the fourth being a medial or azygos lobe. The right upper lobe bronchus usually divides into three branches; the middle lobe bronchus into two branches. The lower lobe gives off a dorsal branch, then a medial one, and beyond this the divisions are inconstant. The left lung usually consists of two lobes, although three lobes were present in one specimen. Here the additional lobe was supplied by a lower branch of the upper lobe bronchus. This latter usually divides into two branches. The lower lobe sends off a dorsal branch and then divides into two main branches.

Autopsy or cadaver lung specimens for teaching and demonstration are prepared by continuous inflation with compressed air over a period of several days. When the lungs are dried in this manner they will remain fixed in the inflated state indefinitely. The lobes and the bronchi (after dissecting them open) are enameled and lacquered.

DISCUSSION

DR. JOHN F. DELPH: It is rather difficult to add anything to Dr. Hagens' excellent presentation. My experience from the anatomic standpoint has been very limited. However, I like his approach to the subject from a new angle, that is, from the inside looking out, which is as it should be. The textbook approach is from an entirely different angle from that of the bronchoscopist.

One can see beyond the end of the bronchoscope, but not through the tracheal or bronchial walls to know what is above or below the end of the scope. This better knowledge of the associated anatomy is useful. Most bronchoscopic examinations are performed for therapeutic drainage of bronchiectatic cavities or lung abscesses, and a smaller number for removal of foreign bodies or biopsy study. Usually the location of the lesion has been fairly well established beforehand through x-ray examination and contrast media, and ordinarily it is not difficult to proceed directly to the site. With removal of the specimen for biopsy or the foreign body it is usually unnecessary to proceed further.

From Dr. Hagen's paper, however, I can see that there are many areas in the lung left unexplored by the usual bronchoscopic procedure. In the obscure case of hemoptysis or purulent discharge one is able to proceed with more certainty if he has firsthand knowledge of the bronchial pattern. True, 20 pairs of lungs cannot give exact details of all lungs, but this study helps to standardize the picture and adds to the work of Huizinga and Behr and De Pablo, mentioned by Dr. Hagens.

Undoubtedly there is considerable anatomic variation in the tracheobronchial tree and it will take considerable time and study to give an accurate picture, but these studies are a valuable addition to what we already know from Jackson and others. There is apparently a regular irregularity about the whole scheme of branches and sub-branches which gives rise to a constant gross pattern within the lung. If this is kept in mind, we can better understand what we are doing when we pass a bronchoscope and be better prepared to seek out the lesser branches for obscure lesions. There are many cases in which physical and x-ray findings are of little help, but with further knowledge of anatomy, new light should be shed on these cases. Undoubtedly lesions occur in the smaller bronchi that cannot be entered with an average sized bronchoscope, but if one knew the approximate location of the mouth of the bronchus, perhaps a curved aspirator or forceps could be used to good advantage, as in entering the upper lobe bronchi.

Huizinga and Behr state that the left main bronchus always divides into two practically equal branches, the bronchi of the upper and lower lobes. The bronchus for the upper lobe invariably runs off laterally. The upper lobe bronchus usually divides into two, the upper and lower bronchi. Dr. Hagens' dissections confirm these statements.

In examining the left lung the upper lobe mouth should be examined first. The technic described by Jackson and Bruning is well known. The first dorsal bronchus of the lower lobe is a large branch which serves an important lung segment in which inflammations are often located. This branch runs off on the posterior side at about the height of the upper lobe bronchus, or a little lower. To see the opening the head must be brought well forward, and if the head is brought back to normal position the tube can be pushed further into the lower lobe bronchus, bringing the remaining portion into view.

On the right side the procedure is somewhat reversed. The bronchus leading to the upper lobe is first examined, then the middle lobe and the ventral branch just below it, and then the lower lobe. These definite procedures are made possible by the studies submitted by Dr. Hagens and others, and I believe that with their help we can further improve our aid to the roentgenologist, the internist and the thoracic surgeon, and probably eventually seek out and explore some ramifications of the tracheobronchial tree which are less known from a bronchoscopic standpoint.

The observations on the blood vessels about the hilar region serve to caution us in the injudicious use of the biopsy forceps and to bear in mind the possibility of disaster if we are too bold.

Dr. Paul Holinger: Dr. Hagens has added a great deal to our information about the bronchial tree. We know from the beautiful description he has had mimeographed for us that his work has been much more extensive than he has shown this evening.

Dr. Lyman Richards raised a question recently of "bronchoscopy at the crossroads." He mentioned that bronchoscopy had been started and fostered by otolaryngologists and the thoracic surgeons had taken it over. Was the otolaryngologist going to continue, or was the thoracic surgeon going to take over bronchoscopic work? These questions are answered in part by work such as this. From what Dr. Hagens has told us there is much more to bronchoscopy than looking into the bronchoscope to find a foreign body or to examine a major bronchus. If we, as otolaryngologists, fail to realize this, we overlook many of the more important phases of bronchology. One must understand the segmental distribution of certain disease processes and, if we examine segments of the lung instead of lobes, we can correlate the bronchoscopic and surgical aspects of pulmonary pathology. The thoracic surgeon can remove segments of a lobe rather than the entire lobe, but must first deter-

mine the segment involved. By bronchoscopy he can be aided greatly in determining before surgery the extent of diseased tissue and normal tissue. The most pertinent illustration of this is the lingula of the left upper lobe which is somewhat analogous to the middle lobe on the right side. It is so frequently involved in bronchiectasis of the left lower lobe that prior to lobectomy the bronchologist must be able to state whether or not it is to be removed with the lower lobe.

From the standpoint of classification, the anatomist classifies the bronchi as posterior or lateral or medial; the clinician and the thoracic surgeon have a different terminology which they develop from a bronchoscopic standpoint, and the effort to correlate these was, I believe, Dr. Hagens' reason for making this study. The terminology used by the bronchoscopist is very important because it stresses the clinical rather than the anatomic standpoint.

We have noticed in our examinations the natural variations in the diameter of the bronchi, as has been mentioned, particularly when we have used photographic apparatus. Ordinarily we use much larger bronchoscopes in photography, yet we can enter the bronchi very easily. Extreme bronchial flexibility must also be considered.

I want to thank Dr. Hagens for his emphasis on the anatomy and terminology in this particular area, in which the otolaryngologist must keep pace with the thoracic surgeon.

Dr. E. W. Hagens (closing): I want to thank Dr. Delph and Dr. Holinger for their discussions. Someone asked about the preparation of the lungs. It is not necessary to do anything except to inflate them. I try to get the blood out of the lungs because I believe it may cause some decomposition, but otherwise they dry and remain in very good shape.

Educational Services to the Deaf and Hard of Hearing in the Chicago Public Schools

MAJOR FRANK L. BEALS

ASSISTANT SUPERINTENDENT OF SCHOOLS

By Invitation

(Abstract)

The story of the development of education for acoustically handicapped children reads more like fiction than factual history. Across the screen of this history pass men of miracles, philosophers dominating medical fact, the neglect of lip or speech reading, codes, the development of schools, the battle between oral and manual methods, until finally, in 1902, came the definite recognition of, and attempts to meet, the needs of these children.

Much of the difficulty in developing schools for the deaf and hard of hearing arose from what Aristotle had to say about them. In about the third century B. C. he said, "Those born deaf all become speechless; they have a voice but are destitute of speech." Further, he called the ear the organ of instruction and said, "Of all the senses, hearing contributes most to intelligence and knowledge."

Under the early Roman law the deaf were classed as incapable, along with madmen and infants. Legal guardians were appointed for them since they were considered unable to perform any legal acts in their own behalf. A person who was slightly deaf was considered adventitiously deaf, or a deaf person giving evidence of intelligence; such a person required no guardian or curator. In the sixth century A. D. the Emperior Justinian commissioned great jurists to prepare a code which bears his name. In this code were included the deaf, and they were divided into five categories:

1. *The Deaf and Dumb by Nature.* They were considered wholly lacking in intelligence, and legally they were not permitted to make wills or contracts, or to act as witnesses.

2. *The Deaf and Dumb by Accident or Disease.* This was considered the adventitious group. If these persons had acquired a knowledge of language, they were permitted to make wills and contracts and perform other legal actions; they were also permitted to marry.

3. *The Deaf from Birth Who Were not Dumb.* These also were considered in the adventitious group.

4. *The Deaf Not from Birth but by Accident.* They were not restricted by law from normal participation in affairs of everyday life.

5. *The Dumb Who Were Not Deaf.* They had, if educated, full legal rights.

This code of Justinian became the basis of later Latin law. The Hebraic law contained an injunction not to curse the deaf. In the Talmud the deaf and dumb were placed on the same footing as fools and children. However, the Talmud did go to the length of stating that the deaf could be taught. The early Christian philosophy taught that the deaf were uneducable.

However, in spite of the uncompromising philosophy underlying the treatment of the deaf at the time, certain people recognized and developed outstanding ability in some of the deaf. Pliny, who lived between 23 and 79 A. D., said of the grandson of one of the Roman consuls, "This young man, being a mute from birth, the orator of Mesala, of whose family he was, thought he might be instructed in painting, of which also Augustus, of sacred memory, approved. The young man made great proficiency in that art." Deaf painters and artists have achieved works of note and have been accorded high rank among the artists of their time in Spain, France, Italy, Germany, Holland and the United States.

It was not until 1500 A. D. that there was a change in the point of view with reference to educating the deaf. It is reliably reported, however, that the Venerable Bede, in 685 A. D., made a dumb boy learn to speak and read the lips. This was regarded as a miracle. In the Church of England, St. John of Beverly is the patron saint of the deaf. However, it was Pedro Ponce de Leon, a Spanish Benedictine monk, who was the first recorded teacher of the deaf. His work was carried on in the monastery of San Salvador at Ona. He taught speech, reading, writing, and arithmetic. Some of his pupils were taught Latin, Greek and Italian. The methods employed by Pedro Ponce de Leon are interesting. They included: writing the names of objects, saying them, associating the two with pantomine and manual alphabet.

But enough of the history of education of the deaf and hard of hearing; with the more modern history we are all thoroughly familiar. The Chicago Public School System provides for the education of these children through classes at five elementary and three high schools.

Organization and Administration of the Audiometric Service in the Chicago Public Schools

KATHERINE BARRETT

CO-ORDINATOR FOR HANDICAPPED CHILDREN

By Invitation

(Abstract)

Prior to 1935 the examination of children for defective hearing was not carried on with any definite plan in the Chicago Public Schools. Children who showed evidence of serious handicap were placed in a special school. They were examined by private physicians or otologists, or in some cases at the Bureau of Child Study. Such procedures were most inadequate in caring for children in the schools as a whole. In 1936 a systematized plan was inaugurated to test children already placed in the special schools. This work was carried on by staff psychologists of the Bureau of Child Study, and through this audiometric service for children already handicapped the need for further and more extensive testing of all school children was brought out.

In May 1938, a W. P. A. project was started, whereby the whispered voice test was used as a screening test throughout all the schools, and children who failed in this test were sent to the Bureau of Child Study for further examination. Here the individual audiometric test was given to determine the decibel loss of hearing. Case histories were taken on all these children and were considered vitally important because they aided in understanding the etiology, made more clear many of the differential diagnoses sent in by attending physicians and otologists, and were helpful in planning the pedagogic and auricular programs. This program was carried on until 1940, during which period 297,172 children were tested. Of this group 5,576 children were referred to the Bureau of Child Study for further examination, and 9,638 were given advantageous seating in the classrooms.

The whispered voice test was discontinued in the fall of 1940, and in its place various audiometer tests were started both for screening and for individual testing. In a 13-month period 69,108 children were tested; 3,221 showed hearing defects of varying degree and of this number 980 were referred for further study.

There are at present five elementary schools acting as centers for deaf and hard of hearing children, and three centers at the secondary

level, two caring for both boys and girls and one, a technical school, exclusively for boys. There is one center at the Spalding School for Crippled Children whose pupils have multiple handicaps, crippled, deaf, or hard of hearing. There is one center at the Washburne Vocational School for boys and girls. Children are sent to these special centers on the basis of the best transportation facilities. All the special centers are equipped with multiple hearing aid machines.

For acoustic training children are divided into three groups. (1) profoundly deaf; (2) congenitally deaf with a small residuum of hearing; (3) hard of hearing. It is felt that children who are profoundly deaf, especially where deafness occurred before speech was developed, will in all probability never build up a hearing vocabulary, but the psychologic effect of acoustic training is valuable. Among the congenitally deaf children there are usually a large number whose audiograms and case histories indicate some residual hearing that has not been developed. In a few instances, after some acoustic stimulation, they have been found to have a hearing vocabulary, although they may be unable to interpret sound correctly.

The hard of hearing cases are divided into severe and mild. The severe cases are given acoustic stimulation and voice and speech training, the same as a deaf child receives, for the establishment of correct speech habits. The mild cases may have most of their academic work programmed to regular grades, but acoustic training is carried on with a group at approximately their own level of development.

The W. P. A. project for screening the hearing of all school children has been of great value because it affords early detection of defective hearing. The individual audiometer examination gives definite decibel loss of hearing and the type of defect. It points to the need either for advantageous classroom seating, transfer to a division of hard of hearing or deaf, or need for otologic care. There is no doubt but that the acoustic methods and electrical hearing aid stimulation are beneficial for the children transferred to the centers.

Studies of case records over a period of years indicate that there is an increased loss of hearing acuity as the child grows older. This would appear to indicate that the earlier a child with defective hearing is found, and otologic care and correct school placement initiated, the better the possibilities of saving the hearing from further loss. Also, it aids the child socially and educationally by the beginning of early acoustic methods, improving speech and starting of training in lip reading.

It is felt, that with proper individualized training at the child's level of achievement, there is no reason to discount the ability of hard of hearing children.

DISCUSSION

DR. ALFRED LEWY: I was enthralled by Major Beals' all too brief historic review of the subject of education of the deaf, and greatly interested in Miss Barrett's statistical review of the work done in the Chicago Schools. Major Beals is to be congratulated on the excellent showing made by our schools, and particularly on the devotion shown by the teachers of the deaf to their charges and to their life work.

It is to be remembered, however, that nearly all the movements in our large cities for the discovery of deaf children in the schools, and the application of remedial measures, to say nothing of the detailed study of the causes of deafness, have been instigated by the medical profession. In 1927-1929, under a Rockefeller Foundation grant and the National Research Council, a survey of the public schools was made under the direction of Dr. George Shambaugh, Sr., assisted by Drs. Curry, Hagens, Hall, Holderman and Watkins; later, Dr. Norval Pierce and Dr. John Theobald surveyed the State School for the Deaf at Jacksonville, Ill. In 1932, Dr. Ballenger, as president of this society, appointed a committee consisting of Dr. Joseph C. Beck, Dr. Shambaugh, Dr. Hagens, Dr. Theobald and myself as chairman, to co-operate with the public schools of the city in the investigation and treatment of deafness. Dr. McMillan, in charge of the Child Study Department, and later his successor, Dr. Munson, co-operated with us. At the beginning 12 doctors, mostly members of this Society, gave their time and energy without pay in visiting the schools, instructing teachers in the whisper test, and directing those in need of treatment to selected clinics which had agreed to co-operate with us.

At that time the principals of the schools tried to help us so far as they could, but with their multifarious duties it soon became evident that paid helpers would be necessary if we were to give hearing tests to all the children. Dr. Bogan, then Superintendent of Schools, appointed a Medical Advisory Committee, consisting of at least one representative of each branch of medicine, with the object of extending complete medical examinations to the school children. Upon his death, I believe that committee went out of existence. Dr. Hayden, then President of the Chicago League for the Hard of Hearing, believed that the screening tests should be done by audio-

meter, while our Committee believed the whisper test would be adequate for this purpose and would not entail the expense of extra equipment. As the result of this disagreement we did not have the co-operation of the League. The expected W. P. A. grant was slow in materializing, but with the co-operation of Dr. Munson classes of school principals were instructed in the technic of the whisper test, they to transmit this to their teachers. In the meantime the doctors of this Society examined in detail at their offices, without charge, such special cases as were referred to them by the schools for the deaf and the Department of Child Study.

Members of women's clubs furnished volunteers who saw to the transportation and chaperonage of these children. Several women's clubs were very active in this work, in particular the Chicago Women's Aid. They donated group hearing aids to at least two schools for the deaf, and they also were responsible for the placing of hearing aids in a number of theatres and churches. I must mention in particular that dynamic personality, Mrs. Sadie Pelton, working through the women's clubs, keeping after us to get things done and getting them done finally.

After the W. P. A. finally took over the work of giving the whisper test to school children, I furnished Major Beals with the names and addresses of several members of our Society who would, without charge, examine clinically such cases as required special attention, as we had been doing before. I do not know how much follow-up work has been done to insure treatment to those found in need thereof. This is the ultimate essential, and I can assure Major Beals that our Society stands ready to co-operate in this.

DR. GEORGE WOODRUFF: Is the incidence of hard of hearing increasing in children in the first grades?

DR. ELMER HAGENS: Is it true that the percentage of children with deafness has increased in the older groups?

MISS KATHERINE BARRETT: An increase has been noted with each grade; in the last year of high school the percentage was 11.1.

DR. ELMER HAGENS: In our survey we found two large groups which were classed as congenital and acquired deafness. In the latter group, 70 per cent had acquired deafness at the age of 5. One would think there would be less increase because of the lesser incidence of infectious diseases in older children. Most deafness is acquired by way of the inner ear. It would be interesting if a survey could

be followed up as the children grew older, with reference to the percentages in congenital and acquired cases.

Miss Katherine Barrett: I should like to ask why otologists report that a child has normal hearing, or sufficiently good hearing to stay in the normal grades, when we have audiograms that show definite loss of hearing?

Dr. Thomas C. Galloway: One difficulty is to agree on standards which should determine whether a child should have special training. We know that some children with a 40 decibel loss in higher frequencies hear speech very satisfactorily, whereas others with a 30 decibel loss may not. Much depends upon the intelligence and alertness of the child, as well as other factors such as the type of impairment. Some standards should be worked out, as definite as may be feasible, for school authorities to use in governing such cases.

Abstracts of Current Articles

NOSE

Sinusitis in Childhood.

Barbosa, J. F., Rev. Brasil, de Oto-Rino-Laring. 11:57-87 (Jan.-Feb.) 1943.

This author presents a study of sinus infection in the infant and young child. The etiology, clinical course of the disease, and its treatment are correlated in various age groups with the anatomical development of the sinuses.

The process of pneumatization is described for each group of sinuses from its earliest identification to complete development.

It is the opinion of the author that what he terms "pathological individuality" in sinuses coincides with the development of their ostia. Previously drainage is unimpeded and subsequently rhinitis and sinusitis exist together. Ciliary action is the most potent influence in healing an infected sinus, but an adequate ostium is necessary.

The Proetz displacement method of filling the sinuses with contrast media and study of the subsequent emptying time is described and considered an essential part of diagnosis. From this study those sinuses which empty within 72 hours are considered as normal. If elimination requires up to 144 hours, the lesion of the sinus mucosa is regarded as reversible and hence favorably influenced by treatment. Beyond that period of time conservative treatment is futile.

Sinusitis in infancy and childhood is much more frequent than is generally believed, and more careful examinations are urged. The disease is nearly always diagnosed in its chronic state, whereas a thorough investigation would reveal it in its acute form when conservative treatment would be effective. The symptomatology in children is obscure. Pain is not generally present. Cough, fever, nasal discharge, loss of appetite, and bronchitis are common symptoms.

In treatment the author stresses hygiene and a diet rich in vitamin A. Vaccine and x-ray treatment have been helpful in individual cases, but in a large series they have been disappointing. The best

results have followed the installation of a one per cent solution of ephedrine in physiological salt solution by the application of negative pressure with the patient in the Proetz or Parkinson position.

HIGBEE.

The Histobacteriology of Chronic Nasal Sinusitis.

Pickworth, F. A.: J. Laryng. and Otol. 58:188 (May), 1943.

The author mentions briefly the various theories applied to the histobacteriology of chronic focal sepsis and finds them inadequate. He feels that neither the property of the invading organism of electing its localization in a specific organ or tissue nor the susceptibility of any organ or locus to infection represents the whole truth. He feels that the proportion of allergic individuals is insufficient to justify the anaphylactic theory of nasal sinus pathology. Evidence regarding the mechanism of surface and blood-borne infections is also not conclusive. It is regarded as established, however, that zones of circumscribed inflammation anywhere in the body attract electro-negative particles, such as viable bacteria, from the circulation and that such localized bacteria may grow and may reenter the circulation.

Pickworth for many years studied the incidence and localization of sinus infection in mental cases. In the tissues of these patients he has failed to find bacteria even when tissue changes normally associated with infection were present. He surmises that these changes are the work of earlier bacterial invaders, now disintegrated.

The author, who had previously drawn attention to the altered morphology which may take place in streptococci growing for a long time in pathological sinus membranes, finds in 40% of the series of 200 specimens of sphenoid bone interlacing filaments with irregularly distributed gram-positive granules which he believes are such morphologically altered streptococci. He states that organisms entering the tissues from the capillaries excite the formation of anti-bodies which set up local reactions to subsequent bacteremias of the same organism. He believes this determines the localization of organisms which have gained access to the blood stream. Since such localizations can occur anywhere in the body, he believes that mental health may become impaired by chronic inflammations of the nasal sinuses when these are associated with histobacteriological changes in the cerebral capillaries.

PHARYNX

Radium Treatment of Granular or Hypertrophied Lateral Pharyngeal Tonsillar Bands.

Fricke, R. E., and Pastore, P. N.: 41:256 (Sept.) 1943.

Although occasionally unattended by symptoms these bands may produce painful and disabling sore throats. During 1939 to 1941 inclusive, at the Mayo Clinic only 24 patients have needed treatment. A metal applicator containing radon is passed through the nasal passage to impinge against the lateral pharyngeal band. 50 mc. radon, 0.5 mm. silver, and 1 mm. brass filtration, and one hour's application to each area furnished the planned dosage. Results of treatment were gratifying. No reactions or injurious effects were noted.

JORSTAD.

Parapharyngeal Phlegmon in the Child.

Oreggia, J. C.: Anal. de Oto-Rino-Laring. del Uruguay 12:210, 1942.

The author reports two cases he considers unique. The first was an acutely ill child of three who, 48 hours previously, had punctured the pharyngeal membrane with a drinking tube. There was considerable hemorrhage at the time of injury. Examination revealed a peritonsillar abscess, which was incised. Five days later the child developed a severe hemorrhage that was controlled by pressure, coagulents, and transfusion. Carotid ligation was advised but refused. The child died of a severe hemorrhage on the ninth day.

The second case was a 19-month-old child who had been acutely ill for 12 days. An x-ray film revealed consolidation in the upper right lobe of the lung. After one month the child developed a necrotic lesion of the left anterior pillar. X-ray films revealed air in the parapharyngeal space and the soft tissues of the neck. The lesion was drained and cultures revealed an anaerobic streptococcus. Five days later the child died of generalized toxemia, the final diagnosis being typhoid fever.

HIGBEE.

LARYNX

Acute Obstructions of the Larynx in the Adult.

Munyo, J. C., and Salveraglio, Fredrico: Anal. de Oto-Rino-Laring. del Uruguay 12:203, 1942.

The picture of acute obstruction of the larynx in an adult presents a complex and spectacular symptomatology. The glottis is the narrowest part of the larynx, thus any lesion obstructing this area will diminish pulmonary aeration and cause dyspnea.

There are three principal signs. This triad is recognized by descent of the larynx during inspiration, super-sternal retraction, and inspiratory dyspnea.

The secondary signs are slowing of respiratory rhythm, disturbance of voice, cough, auscultatory apnea (especially in base), cyanosis of the face, venous stasis, paradoxical pulse, and retraction of the head in an attempt to improve respiration.

Conditions that may provoke an acute obstruction of the larynx are: acute infectious edema of the larynx, edema of renal origin, angioneurotic edema, laryngeal erysipelas, secondary edemas, acute crico-arytenoid arthritis, foreign body, croup, laryngotracheobronchitis, and laryngeal typhus.

Serum reactions producing an acute laryngeal obstruction may cause death unless an immediate tracheotomy is done.

HIGBEE.

EAR

Deafness in Infancy and Early Childhood.

Ewing, I. R.: J. Laryng. and Otol. 58:137 (April) 1943.

This is an account of experiences with infants in a clinic for the deaf established in 1934 at the University of Manchester. Thirty unselected deaf children were studied. Ten were under two years of age and twenty were between the ages of two and three at their first visit. Their development was compared with that of infants and preschool children with normal hearing according to the standards laid down by Gesell. They were observed for motor development, adaptive behavior and language, the latter including vocalization, speech

and auditory comprehension. It is pointed out among other things that vocalization and its preservation is of importance even to the child who cannot hear any sound of it. If he is "encouraged constantly to use his voice to attract attention to his wants and he is led gradually to understand the kind of voice that pleases others and wins for himself the thing he wants, his use of a pleasant voice becomes habitual."

It is pointed out that gesture serves more or less satisfactorily for bodily wants but does not serve adequately for stimulation for the mind and does not serve in rationalizing a child's security. The author believes that the early approach to speech in the very young deaf child influences for life his attitude toward it and points out the necessity of a specially qualified teacher in accomplishing this purpose.

The Nature of Deaf Mutism—Childhood and Adolescence.

Ewing, A. W. G.: J. Laryng. and Otol. 58:143 (April) 1943.

A continuation of the foregoing, this paper contains some very important information regarding the responses of children of various ages and degrees of deafness to speech, hearing aids and lip reading. For example, a group of children who showed any capacity to hear speech was 33% more accurate in recognizing it with the hearing aid and the lip reading together than they were when relying on lip reading alone. It is pointed out that, although it is in no sense a substitute for lip reading, a hearing aid is a form of mental stimulation which should be provided.

Another interesting observation related to motor control. It was found that children who could not hear speech were deficient in body balance and general static coordination. The remainder of the paper deals with mental versatility and adaptation to word groups and minor changes in word groups.

The author adopts as a criterion to success with the deaf child "How far is the intervention of the teacher making speech a bridge between these children and the normal world?" and "To what extent are the children learning to enjoy conversation with normal people out of school as well as in school hours?"

MISCELLANEOUS

Severe Forms of Monocytic Angina.

Regules, Pedro, and Leunda, J. J.: Anal. de Oto-Rino-Laring. del Uruguay 12:117, 1942.

The authors limit their paper to pointing out the difficulties in making a clinical diagnosis of monocytic angina and stress the necessity of making a correct diagnosis in order that the prognosis can be determined.

Three types of angina are listed: the monocytic form, which usually results in recovery; the agranulocytic form, which is frequently fatal; and the leukemic form, which is always fatal.

Diphtheria is frequently a source of confusion in diagnosis and must be ruled out on the basis of bacteriologic, serologic, and hematologic tests.

The authors call attention to the fact that mononucleosis may produce a fatal bulbar paralysis.

HIGBEE.

Allergy in Otorhinolaryngology.

Ruiz, Mario: Anal. de Oto-Rino-Laring. del Uruguay 12:149, 1942.

The diagnosis of allergy is based on the complete personal and family history, physical examination, and cutaneous reactions. Local eosinophilia is easy to find by examination of nasal smears and is a sign that seldom fails.

In the external ear so-called eczema is usually of allergic origin and may be due to hair dye, soaps or perfumes. Frequently the cervical lymph nodes are involved, or the condition may simulate a rubella.

Another syndrome that may be allergic in origin is obstruction of the eustachian tubes. When improvement of this condition is not obtained by catheterization, recovery often follows calcium medication and specific desensitization. Gutierrez has found eosinophiles in the mucosa of the eustachian tubes in patients with a catarrah of the external ear canal.

In all suppurations of the ear with central perforation of the drum membrane, it is well to remember calcium medication and specific desensitization.

The common cold, bronchitis (particularly in children), nasal obstruction, pharyngitis, laryngitis, and esophagitis are many times found to be caused by allergy. Surgery is often performed for the relief of these conditions without success. When specific desensitization and calcium medication are instituted, many of these cases are relieved.

HIGBEE.

Herpes Zoster of the Seventh, Ninth and Tenth Cranial Nerves. Report of a Case.

Negus, V. E., and Crabtree, N. C.: J. Laryng. and Otol. 58:192 (May) 1943.

The condition was noted in a girl, aged 20, and was characterized by the following symptoms: pain and watery discharge from the right ear, the hearing of which was unaffected; difficulty in swallowing; aphonia; intermittent right frontal pain; right-sided facial paralysis.

There was external otitis with vesicles at the entrance of the canal. There were herpetic vesicles on the right side of the hard palate, mild pharyngitis and slight edema of the faucial pillars of the soft palate; the latter was paralyzed on the right. Sensation was diminished on the right side of the palate and the posterior pharyngeal wall. There was a diminution of taste perception on the right side of the tongue and failure of lacrimation in the right eye following nasal stimulation. The right cord was immobile and there were herpetic vesicles on the right superior border of the epiglottis and on the posterior part of the right original epiglottic fold. The patient had practically recovered by the 29th day.

Infection of the Meninges in Maxillary Sinusitis.

Spencer-Harrison, Capt. M. E., R.A.M.C.: J. Laryng. and Otol. 58:196 (May) 1943.

This case is of interest particularly because of the route which the infection took following a Caldwell-Luc operation performed three months after an acute attack of maxillary sinusitis. The cheek swelled to an unusual extent and subsequently signs of intracranial infection began to develop. Meningitis was demonstrated five weeks after the operation. This responded to treatment with sulfapyridine but an abscess developed in the cerebello-pontine angle and two others in the cerebellum which proved fatal.

Autopsy showed the route of infection from the cheek to have been via the infra-orbital nerve, the infra-orbital canal and the middle fossa.

Notices

CASSELBERRY AWARD OF THE AMERICAN LARYNGOLOGICAL ASSOCIATION

A sum of money having accrued from the Casselberry Fund of the American Laryngological Association, a prize will be offered in 1944 for original investigation in the art and science of laryngology or rhinology. Theses must be in the hands of the Secretary, Dr. Arthur W. Proetz, 1010 Beaumont Building, St. Louis 8, Missouri, before March 1, 1944.

AMERICAN BOARD OF OTOLARYNGOLOGY

The next examination of the American Board of Otolaryngology will be held in New York at the Waldorf-Astoria Hotel on June 1, 2, 3 and 4. Communications should be addressed to the Secretary, Dr. Dean M. Lierle, University Hospital, Iowa City, Iowa.